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Supervision of Physical Education in the Elementary School

Part II—The Classroom Teacher's Viewpoint

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Abstract

This study is concerned with in-service practices of elementary classroom teachers in public schools which had previously been suggested by the various state departments as having adequate supervisory service. Eighty-nine classroom teachers replied. The data show that classroom teachers who are adequately supervised present a picture of the educationally better practices at the elementary school level in respect to planning, correlation of physical education with other subjects, regard for learning problems and those of organization and grouping, use of evaluation, and awareness of in-service procedures found to be helpful. Comparisons are made with a previous study of the supervisors' viewpoint in the same situations. The two studies have value for teacher education at both pre-service and in-service levels.

THIS STUDY IS A sequel to one conducted during 1951 and published in the *Research Quarterly* in December 1952 under the same title but with the sub-title of "Part I—The Supervisor's Viewpoint." The present study, "Part II—The Classroom Teacher's Viewpoint," like Part I, was carried on by the Elementary School Subcommittee of the Committee on Trends as they Affect Physical Education for Women and was sponsored by the National Association for Physical Education of College Women.

Purpose of the Study

As indicated by the title and sub-title, this study serves as the counterpart to that of 1951. The purpose of this study was, then, to pursue further the inquiry into in-service supervisory practices in the same public school systems used in 1951 but through a direct contact with the regular elementary classroom teachers who were conducting the physical education program under the supervisors who had reported for the 1951 study.

It should be recalled that the public school systems used in 1951 were those that the various state departments listed as having adequate supervisory service at the elementary school level.

Procedure

1. In the fall of 1952, 80 of the 103 supervisors who had responded to the 1951 inquiry were asked to assist with a follow-up study. Selection of supervisors was made on a basis of ready responsiveness to the questionnaire and also on geographic spread.

Specifically, these supervisors were asked to select from their respective public school systems the names of several classroom teachers who were regularly and actively teaching physical education to the children of their grades and who would be willing to answer a questionnaire on the procedures they were using in that teaching.

2. A brief explanatory letter and a questionnaire were sent to all classroom teachers whose names had been received—a total of 172.

3. By March 1953, 91 replies had been received, i.e., 53%. Of these, two that had been answered by physical education teachers were discarded. The 89 questionnaires used were from classroom teachers in 50 cities or towns of 26 states. Compared with the 1951 study, there were no reports from Arkansas, Connecticut, Indiana, Nebraska, New York, North Dakota, Tennessee, or Utah. Among the 89 reports, 12 were from teachers of combined grades and 1 each from the seventh and eighth grades. The remaining 75 averaged 12 reports from each grade, first through sixth.

Findings on Preparation

Preparation in Graded Activity Experiences: More than two-thirds to three-fourths of the teachers reported adequate pre-service preparation with team games and low organized games; well over half had adequate preparation in dance and rhythm activities; almost half believed themselves to be adequately prepared in stunts and self-testing materials. (See Table 1.)

TABLE 1

Data on Pre-Service Preparation of the Classroom Teacher for Teaching Physical Education

	Yes	*No.*	*No Answer*
1. Were you given adequate preparation in graded activity experiences such as the following:			
Low Organized Games	77.5 %	20.2 %	2.2 %
Team Games	64.0 %	21.3 %	14.6 %
Dance and Rhythm Activities	56.17%	28.0 %	15.73%
Stunts and Self-Testing Materials	46.0 %	44.9 %	8.98%
(Other)	15.73%	5.61%	78.65%
2. Were you given enough help in the analysis of skills to assist in motor learning of your grade pupils?	33.69%	49.43%	16.85%
3. Were you given adequate background on special methods used in teaching physical education?	44.67%	50.56%	3.37%
4. Were you given adequate help on the mechanics of class organization?	59.55%	34.83%	5.61%
5. Were you given adequate help in planning the physical education program?	53.93%	33.70%	12.36%
6. Were you given adequate help with evaluation procedures for the physical education program?	24.71%	48.31%	26.96%

Preparation in Analysis of Skills: Only one-third of the teachers felt that they had been helped sufficiently in the analysis of skills to assist in the motor learning of their grade pupils; almost half felt that they definitely had not been helped sufficiently in this respect.

Background in Special Methods: Almost half of the teachers believed that they had received adequate background on special methods for teaching physical education; half reported that they had not received sufficient help in this area.

Preparation on Mechanics of Class Organization: In general, almost two-thirds of the teachers felt that they had received adequate help on the mechanics of class organization, while approximately a third felt an inadequacy in this regard. Specifically, almost two-thirds to almost a half of the teachers reported adequacy of preparation in the following order: Methods of organizing the class in space, methods of grouping children, methods of moving a group from one formation to another, and use of signals.

Preparation in Planning the Physical Education Program: Over half of the group believed that they had received adequate help in planning the physical education program, while a third felt that they had not. Two-thirds of the teachers reported adequate preparation in adapting the work to the age and maturation of their grades and almost two-thirds believed they had adequate preparation in the planning of daily lessons, and in the integration of physical education activities with other school subjects. Over half were satisfied with their preparation in the formulation of goals.

Preparation in Evaluative Procedures: In general, a fourth of the group believed they had received sufficient help with evaluation procedures for the physical education program; nearly half believed they had received insufficient help in this respect. Specifically, the types of evaluation on which adequacy of help was reported by almost a half to a less than a fourth of the classroom teachers were, in order, as follows: the health examination, informal tests, subjective evaluation, and standardized tests.

Summary of Findings on Preparation

In general, in regard to preparation for teaching physical education, the 89 classroom teachers reporting from public school systems in which the supervision was considered adequate by the respective state departments felt most secure in their preparation in graded activity experiences. Next in order were mechanics of class organization, planning the physical education program, background on special methods, analysis of skills, and evaluation procedures for the physical education program.

According to Table 2, game material is obviously the most available type of experience for the classroom teacher, with dance material second, and stunts and tumbling material third. Other materials specifically mentioned were records, visual aids, piano, charts, note book, card catalogue, motion pictures.

TABLE 2

Data on Types of Physical Education Literature Available to the Classroom Teacher

Type	Games	Dance	Stunts & Self-Testing	Other
Books	76	67	49	3
Periodicals	23	17	14	—
Bulletins	48	25	30	2
Courses of Study	66	47	43	3
Others	14	26	5	2
	227	182	141	10

Findings on Curriculum Procedures

Use of Unit Plan: Almost two-thirds of the teachers make use of a resource or teaching unit in physical education; a fourth do not. These unit plans are prepared either by the local supervisor or, in a little more than half of the cases, by the teacher herself.

Use of Lesson Plan: A fifth of the teachers make no use of a lesson plan for physical education. Over a half make use of a skeletal plan and less than ten per cent make use of a detailed plan. Other mention was made of a weekly plan, a list of the day's activities, and a simple outline.

Correlation with Other Subjects: Almost three-fourths of the teachers report correlation of physical education with music; almost two-thirds report correlation with social studies. Other mention was made of arithmetic, health, reading, science, history, dramatics, the alphabet, and all subjects.

TABLE 3

Data on Curriculum Procedures Used by Classroom Teachers in Teaching Physical Education

	Yes	*No*	*No Answer*
1. Data on use of unit plan.			
Do you make use of the resource or the teaching unit in physical education?	61.79%	25.84%	12.35%
Do you use unit plans that:			
have been prepared by yourself?	52.80%	14.60%	32.58%
have been prepared by local supervisor?	53.93%	14.60%	31.46%
have been prepared by (other)?	11.23%	8.98%	79.77%
2. Do you make use of a lesson plan?	60.67%	20.22%	19.10%
3. Do you make use of correlation of physical education with other subjects?			
With music	73.03%	———	26.96%
With social studies	61.79%	———	37.97%
(Other)	29.21%	———	70.78%

Summary of Findings on Curriculum Procedures

Almost two-thirds of the teachers make use of a long-time plan of some sort. Game materials are used most frequently and on an average of about 3 to a teacher, dance materials second and on an average of about 2 to a teacher, and stunts and self-testing materials third in almost a 2 to 1 relationship. A little more than half of the teachers use a skeletal plan, only very few use a detailed plan and one-fifth use no lesson plan for physical education.

A large proportion of the teachers report correlation of physical education with other subjects, the first of which is music, second social studies, and a long list of specific ways of using these correlations as well as the addition of the alphabet, arithmetic, health, reading, science, history, dramatics, and all subjects.

Findings on Methods and Materials

Learning Problems: In the area of general learning problems, those of ball skills are experienced by more than half of the teachers, those in rhythm and dance by exactly half of the teachers, and posture and foot problems by a third of the teachers. Other general learning problems mentioned were those concerned with health habits and correlation with other subjects.

In the area of specific learning problems, those concerned with co-ordination in catching form and throwing form are problems of about two-thirds of the classroom teachers; kicking form was a problem with a little more than a fourth of the teachers contacted.

TABLE 4

Data on Methods and Materials Used in Physical Education by Classroom Teachers

	Yes	*No*	*No Answer*
1. Learning Problems			
Which of the following learning problems do you encounter most frequently in your grade?			
General Problems			
Rhythm and dance problems	50.56%	22.47%	24.71%
Ball skill problems	56.17%	21.34%	22.47%
Posture and foot problems	34.83%	25.84%	39.32%
(Other)	6.74%	4.49%	88.76%
Specific Problems			
Co-ordination			
In throwing form	62.92%	14.60%	22.47%
In catching form	66.29%	12.35%	21.34%
In kicking form	28.08%	21.34%	50.56%
In (other)	4.49%	6.74%	88.76%
Timing of movements	33.70%	13.48%	52.80%
Balancing of body	31.46%	16.85%	51.68%
Speed of locomotion	25.84%	19.10%	55.05%
Endurance	16.85%	20.22%	62.92%
2. Organization and grouping problems			
Do you frequently have problems in:			
Arranging group in files, etc?	21.34%	67.41%	11.23%
Placing group well in given space?	15.73%	64.04%	20.22%
Using leaders for squads and teams?	19.10%	61.79%	19.10%
Grouping boys and girls together:			
in dance?	30.33%	55.05%	14.60%
in games?	11.23%	64.04%	24.71%
in stunts?	17.97%	52.80%	29.21%
3. Types of evaluation of achievement used.			
Check the means of evaluation you have found most effective:			
Standard achievement test	6.74%	———	93.26%
Local standards	43.82%	———	56.18%
Knowledge tests	14.60%	———	85.39%
(Other)	15.73%	———	84.27%

Timing of movements is a second area of specific problems and occurs in a third of the teaching group; balancing of the body is a third area of specific problems and occurs in almost a third of the group; speed of locomotion is fourth in order of specific learning problems, and was reported by a fourth of the teachers; endurance problems were fifth in rank order and were experienced by a sixth of the teaching group.

Organization and Grouping Problems: Organization and grouping problems are found first by almost a third of the teachers when grouping boys and girls together for dance, by about a fifth of the teachers when arranging a group in files and other formations, when using leaders for squads or teams, and when grouping boys and girls together for stunts; only 15 per cent experienced a problem in placing a group well in a given space, and only 11 per cent when organizing boys and girls for games.

Types of Evaluation Used and Found Effective: Local standards are used most frequently as a means of evaluation, that is, in the case nearly half of the teachers. About 15 per cent of the classroom teachers use knowledge tests and "other" means of evaluation; this latter category includes such specific means as: charts for self-evaluation, progress charts, evaluation through group discussion, individual records, pentathlon, personal standards. Standard achievement tests were used by only about seven per cent of the classroom teachers.

Findings on In-Service Procedures

The classroom teachers have found in-service procedures to be helpful in the following order: demonstrations, bulletins, group conferences, individual conferences, visual aids and visitations, workshops and short courses.

TABLE 5

Data on In-Service Procedures Considered Helpful by Classroom Teachers

Of the following general procedures used in in-service education, check those found most helpful:	*Yes*	*No Answer*
Bulletins	51.68%	48.31%
Group conferences	43.82%	56.18%
Individual conferences	41.75%	58.42%
Demonstrations	79.77%	20.22%
Workshops and short courses	30.33%	69.66%
Visual aids	34.83%	65.17%
Visitations	34.83%	65.17%
(Other)	5.61%	94.38%

Additional Comments from the Classroom Teachers

Comment Upon Replies Given: About a third of the teachers made comments and in the following categories:

1. In-service assistance that had been valuable such as the following: short courses, workshops, demonstrations, bulletins from supervisors, special materials for new teachers, course of study, outlined plans, summer recreation program, special assistant, availability of the supervisor.

2. Needs in pre-service and in-service education such as: nothing prepared for a given level of teaching, teachers college preparation inadequate, need of classroom teacher to

understand objectives and physical education methods, no preparation at all in physical education, more help through visitation.

3. Facilities: limited space, overcrowding.

4. Program: physical education integrated with every other subject, play days a great incentive, much experimentation.

5. Satisfaction in accomplishment and in excellence of the supervisor.

Other Areas in Which Help Is Needed: About a fifth of the teachers responded to this opportunity. The comments fell in the following categories:

1. Program: Most of the comments fell under this heading and included the need for organized games for large groups, planning a yearly program, safety especially in tumbling classes, activities that can be used in the classroom, and also more materials in the game, dance, and stunt areas of activity.

2. Knowledge of the child especially in regard to specific needs of the child and individual differences.

3. Size of group problems.

4. Time problem.

Conclusions

The study of Supervision of Physical Education in the Elementary School, Part I, carried on in 1951-52, and the present study of 1952-53, Part II, contain some bases for interesting comparisons. However, that of 1951-52 sought reactions from supervisors who reported on total school systems and that of 1952-53 sought reactions and practices of individual classroom teachers working with those supervisors.

The questionnaire used in 1952-53 was definitely shorter than that of the previous year because the classroom teacher was being asked to perform a service in another field than hers and also because her role in physical education is necessarily narrower than that of the supervisor.

Ways in Which the Two Studies Compare with Each Other

1. *Preparation of the Classroom Teacher in Physical Education.* In the 1952-53 study, the classroom teachers generally believed themselves more adequately prepared than the supervisors thought them to be, e.g., in the area of team games, more than two-thirds of the 89 classroom teachers reported adequate preparation whereas in 47 per cent of the 103 school systems, the supervisors believed classroom teachers to have definite lacks in team games. Similarly, in the area of dance and rhythm, over half the teachers thought themselves adequately prepared while in 81 per cent of the public school systems, the supervisors reported this the top-ranking area of lack. Similar differences in belief regarding preparation were shown in regard to planning the physical education program, background in special methods, and analysis of skills.

2. *Planning by the Classroom Teacher.* The long-time or unit plan in physical education and also the lesson plan are apparently used by the majority of the classroom teachers and also in the majority of the public school systems.

3. *Types of Physical Education Literature.* One point of similarity in the reports of both supervisors and classroom teachers is the relative availability of materials, those for games in each case having a rank order of one, those

for dance a rank order of two, and those for stunts and tumbling a rank order of three.

4. *Use of Correlation with Other Subjects.* Correlation of physical education with music had the highest frequency in both studies; both also reported correlation with social studies second.

5. *In-Service Procedures.* The classroom teachers' beliefs in regard to the relative helpfulness of in-service procedures bore a close similarity to the rank order of the frequency of their use by the supervisors. With visitation by the supervisor assumed in the case of the reports of the classroom teachers, the procedures appeared in the following order in both studies: (1) demonstrations, (2) use of bulletins, (3) group conferences, (4) individual conferences, and (5) work shops.

Ways in Which the Two Studies Supplement Each Other

In several respects the studies supplement each other. For example, the 1951-52 survey of supervisors gives a report of the type of evaluation used by the classroom teacher and the 1952-53 survey of classroom teachers reports the types of evaluation found to be most effective by the classroom teacher.

In respect to recurring learning problems, the classroom teacher survey presents those encountered most frequently, while the supervisor survey gives a report of the procedures used to meet the learning problems.

Other instances of supplementation are to be found in relation to the topic of organization and grouping.

Selection, A Characteristic of Both Studies

Both studies are concerned with selected situations. Those of the 1951-52 study were chosen upon the direct advice of the state departments that in those instances the supervision was adequate or better. In the 1952-53 study, the supervisors were asked to name the classroom teachers who were actively and regularly teaching physical education to the children of their grades and also who would be willing to answer a questionnaire on the procedures they were using. Without doubt, the two studies present a picture of the better practices that exist in the conduct of the elementary school program of physical education.

Implications for Teacher-Educating Institutions

In spite of the many sound features presented by these studies, there are many data that suggest needed improved emphases in the curricula of teacher-educating institutions. It must be remembered, too, that while these reports from selected supervisors and teachers set forth practices and viewpoints that are at the upper end of the continuum, the more common situation in regard to the teaching of physical education would doubtless appear at a considerably lower level.

Inasmuch as studies since 1940 show that the classroom teacher most frequently carries the responsibility for the teaching of physical education at the elementary school level, the nature of her pre-service education in this area deserves earnest study of all institutions preparing elementary teachers.

(Submitted 11-13-53)

Physical Education Interests and Needs of University of Washington Women in Service Classes

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Abstract

This study reports the results of a questionnaire concerning the physical education interests and needs of 1,155 Freshman and Sophomore women at the University of Washington. Information dealing with student objectives, opinion of the requirement and the granting of credit, activities which should be taught, level of instruction desired, interest in coeducational instruction, reaction to activities taken in college, previous instruction and recreational participation, is included. The two objectives "to develop skill in various sports" and "to learn activities that can be continued outside of school" were checked by over 90 per cent of these students.

THE SWIFTLY MOVING social and economic developments of today constantly bring the American public face to face with the problems of health, successful group relationships, and the constructive use of leisure time. It is current educational philosophy that the schools must be concerned with educating the youth of America to more intelligently meet these problems. It is believed that this purpose will be accomplished more successfully if student objectives are satisfied and their needs and interests met in a way that is both pleasant and stimulating to the students. The first step in such education is obviously the determination of the needs and interests as the students themselves see them. This study was undertaken in an attempt to discover the current objectives, needs, and interests of the women students in physical education activity classes at the University of Washington, so that the departmental objectives and curricular offerings could be studied and, if necessary, redefined in light of student exigency.

Purpose

It is the purpose of this study to determine to what extent the Department of Physical Education for Women at the University of Washington is satisfying current student objectives and meeting student interests and needs, as the students see them.

Procedure

During the winter quarter[1] 1952 an extensive questionnaire was administered to women students enrolled in physical education service classes at

[1]The University of Washington is organized on the quarter system and six quarters (two years) of physical education are required.

the University of Washington. Physical education majors who were enrolled in service classes were omitted from the study. The questionnaire was administered during the physical education classes and no attempt was made to secure results from students who were absent on the days when it was administered.

In all 1,155 students answered the questionnaire. Of these approximately 4 per cent were enrolled in their first class of physical education activity. The largest group (47%) were taking their second class, and 31 per cent were in their fifth activity class. Smaller groups (approximately 5%) were taking their third, fourth, and sixth activity and approximately 2 per cent had completed six or more classes of physical education activity.

Results

OBJECTIVES

Students were asked to check those objectives listed on the questionnaire which they hoped to achieve through participation in physical education classes. If they had other objectives for physical education than those listed, they were asked to add them to the list.

The two objectives "to develop skills in various sports" and "to learn activities that can be continued outside of school" were checked by over 90 per cent of these students. It is interesting to note that five girls added the objective "to develop known skills and learn new ones." Considering that the first objective listed is similar, this would indicate a very definite desire to learn skills. Two girls added the objective "to learn hobbies and recreational interests" which is practically the same as that which was second in popularity "to learn activities that can be continued outside of school."

The number and percentage of students claiming various objectives for physical education are listed in Table 1.

ACTIVITIES TO BE INCLUDED IN THE PHYSICAL EDUCATION PROGRAM

Thirty-four activities were listed on the questionnaire and the students were asked to check those which they felt should be included in the physical education service program. They were also asked to note which activities should be a part of a women's program and which should be included in a coeducational program.

With the exception of track and field, no activity was checked for inclusion in the women's program by less than 40 per cent, and 22 activities were checked by over 75 per cent. (See Table 2.) The ten top-ranking activities are swimming, tennis, bowling, golf, lifesaving, diving, badminton, water safety, skiing, and folk dancing in that order. It is interesting to note that there are four water sports and no team sport included in this group. The inclusion of water activities by such large numbers is understandable in light of the geography of the area in which these students are living. Of the team sports only basketball and volleyball fall within the first 20 activities. The only activities listed on the questionnaire that were checked by less than half the students were soccer, speedball, field hockey, and track and field.

TABLE 1

Number and Percentage of Students Claiming Various Student Objectives in Physical Education

Objectives	Number	Per Cent
Listed in the questionnaire:		
To develop skills in various sports	1061	91.8
To learn activities that can be continued outside of school	1040	91.1
To have fun	964	83.5
To keep in good health and physical condition	875	75.8
To learn to handle my body more efficiently	846	73.2
To understand games so I can be a more intelligent observer	840	72.7
To develop flexibility	694	60.0
To make new friends	648	56.1
To improve in grace and poise and to overcome awkwardness	640	55.4
To understand the strategy of games	637	55.2
To develop endurance to prevent tiring easily	626	54.2
To develop better posture	625	54.1
To improve personal appearance with better physical proportions	555	48.0
To improve my carriage	528	45.7
To learn to control myself and be a "good sport"	488	42.3
To get along with and understand other people	466	40.3
To overcome self-consciousness	416	36.0
To develop strength	345	29.9
To feel that I belong to a group	256	22.2
Added by the students:		
To get credit for grade	27	2.3
To meet requirement	17	1.5
To relax, let off steam, break monotony of lectures	12	1.1
To get exercise	6	.5
To teach others	4	.3
To develop rounded appreciation and interests in sports	3	.3
To take part fairly well in many activities	2	.2
To get self-satisfaction	2	.2
To keep occupied	2	.2
To learn for competition	2	.2
To develop good condition for out-of-school sports	1	.1
To learn sports with and without partner	1	.1
To use unused muscles	1	.1

Among the activities checked for coeducational classes, social dancing, as might be expected, was checked by the most students (81%). Folk and square dancing was a close second with approximately 80 per cent checking it. Sailing, skiing, bowling, tennis, golf, international dance, ice skating, and riding were next in this order, to make up the first ten. All of these activities are individual or dual in nature, have "date" possibilities and, with the exception of tennis, all have commercial outlets in the Seattle area. It is interesting that relatively small percentages of students indicated that co-educational swimming and diving should be included in a physical education curriculum, yet these two activities were among the top ten that were checked for inclusion in the women's program, swimming being first. These differences can probably be explained by a feeling of insecurity on the part of

TABLE 2

Number and Percentage of Students Selecting Each Course To Be Offered in a Physical Education Program and To Be Offered as a Coeducational Activity

Activity	Women's Program		Coeducational	
	Number	Per cent	Number	Per cent
Archery	952	82.4	199	17.2
Badminton	1070	92.6	459	39.7
Bowling	1107	95.8	777	67.3
Canoeing	973	84.2	548	47.4
Fencing	785	68.0	114	9.9
Golf	1091	94.5	724	62.7
Riding	1007	87.2	693	60.0
Sailing	976	84.5	850	73.6
Skating, Ice	908	78.6	700	60.6
Skating, Roller	696	60.3	568	49.2
Skiing	1046	90.6	846	73.2
Stunts and Tumbling	739	64.0	81	7.0
Tennis	1115	96.5	737	63.8
Track and Field	255	22.1	21	1.8
Swimming	1133	98.1	203	17.6
Diving	1071	92.7	138	11.9
Rhythmic Swimming	920	79.7	107	9.3
Lifesaving	1091	94.5	215	18.6
Water Safety Instruction	1054	91.3	198	17.1
Basketball	944	81.7	61	5.3
Field Hockey	473	41.0	23	2.0
Softball	880	76.2	109	9.4
Soccer	513	44.4	27	2.3
Speedball	468	40.5	19	1.6
Volleyball	963	83.4	190	16.5
Folk and Square Dance	1017	88.1	908	78.6
International Dance	846	73.2	707	61.2
Modern Dance	902	78.1	265	22.9
Social Dance	941	81.5	936	81.0
Tap and Clog Dance	754	65.3	221	19.1
Basic Skills	594	51.4	27	2.3
Body Mechanics	762	66.0	35	3.0
Conditioning	718	62.2	23	2.0
Posture Correction	1002	86.8	32	2.8

the girls in learning situations where the competition with men might be too great. Coeducational instruction in the body mechanics type of class obviously is not desired by these students and the same is true of the team sport activities with the possible exception of volleyball.

Students were asked to list other activities that they thought should be included. No activity that was added by the students was listed by more than 5 per cent. Table tennis was listed by 5 per cent for the women's program and by 1 per cent for the coeducational program. From 1 to 4 per cent of the students listed hiking, riflery, ballet, billiards, water skiing, climbing, bicycling and football for the women's service program, and all of these activi-

ties, with the exception of football, was listed by a very small percentage for inclusion in the coeducational program. Twenty-seven other activities were listed for the women's program by from one to seven students, and nine were listed by only one or two students for the coeducational program.

PREFERENCE FOR ACTIVITIES

The students were then asked to note the activities of their first, second, and last choice. All activities listed received some first and second choices, and all were checked as least liked by some students. This shows a wide variety of interests and indicates that no matter how popular an activity may be some students will like it least, and vice versa.

When students were asked to check the three activities in which they were the most interested, the activities checked by the greatest number were swimming, bowling, tennis, sailing and skiing, in that order. Students were asked to select six additional activities in which they were interested but not as interested as those chosen first. Tennis, canoeing, badminton, golf and bowling (in that order) were chosen by 36 per cent or more of the students. Bowling and tennis appear in the upper five of both lists and both lists are composed entirely of individual and dual sports.

Among the activities chosen as last choice, track and field was highest with 46 per cent of the students indicating that they liked it least. Field hockey was second (45%). Stunts and tumbling, soccer, and fencing were checked as least liked by 18 to 30 per cent of the students. Since the question was stated "least liked" activities, activities which were unknown could have been checked and therefore, the results do not necessarily indicate a known dislike.

The results indicate a decided disagreement among the students in preference for archery, fencing, basketball, modern dance, and tap and clog dance.

Eighteen activities were added by the students as first or second choice but all were added by less than 1 per cent.

DESIRED INSTRUCTION

From Table 3 it can be noted that the students indicated an interest in beginning, intermediate, and advanced instruction in approximately the same activities, though the first ten activities rank in a little different order for the three levels. The ten activities that rank highest in desired instruction, all levels considered, are tennis, swimming, bowling, skiing, golf, sailing, diving, riding, badminton, and canoeing, in that order.

More students indicated a desire for beginning instruction than for instruction at any other level. There are eight activities in which over half of these students desire beginning instruction (tennis, sailing, skiing, golf, bowling, swimming, canoeing, riding). There is only one (tennis) in which half desire intermediate instruction but over one-third desire this level of instruction in swimming, bowling, golf, and skiing. Over one-fourth desire advanced instruction in swimming, tennis, skiing, and bowling.

TABLE 3

Number and Percentage of Students Desiring Various Degrees of Instruction in Various Activities

Activity	Beginning Instruction		Intermediate Instruction		Advanced Instruction	
	No.	Per cent	No.	Per cent	No.	Per cent
Archery	310	26.9(14)[1]	132	11.4(15)	49	4.2(20)
Badminton	411	35.6(11)	291	25.1(7)	202	17.4(8)
Bowling	663	57.4(5)	482	41.7(3)	346	29.9(4)
Canoeing	611	52.9(7)	187	16.2(12)	90	7.8(16)
Fencing	283	24.4(17)	85	7.3(20)	37	3.2(23)
Golf	717	62.1(3)	396	34.2(4)	253	21.9(5)
Riding	604	52.3(8)	253	21.9(9)	181	15.7(9)
Sailing	760	65.8(2)	287	24.9(8)	210	18.2(7)
Skating, Ice	511	44.2(10)	207	17.9(10)	136	11.8(11)
Skating, Roller	263	22.8(18)	135	11.7(14)	91	7.9(15)
Skiing	717	62.1(3)	379	32.8(5)	350	30.3(3)
Stunts and Tumbling	111	9.6(26)	45	3.9(26)	29	2.5(25)
Tennis	785	68.0(1)	604	52.3(1)	456	39.5(2)
Track and Field	48	4.1(30)	21	1.8(29)	9	.8(30)
Swimming	626	54.2(6)	496	42.9(2)	539	46.6(1)
Diving	562	48.6(9)	295	25.5(6)	229	19.8(6)
Rhythmic Swimming	288	24.9(16)	97	8.4(19)	92	8.0(14)
Lifesaving	347	30.0(12)	120	10.3(16)	112	9.6(13)
Water Safety Instruction	228	19.7(20)	81	7.0(21)	78	6.8(17)
Basketball	147	12.8(23)	81	7.0(21)	43	3.7(22)
Field Hockey	36	3.2(32)	8	.7(32)	6	.5(31)
Softball	82	7.1(27)	46	4.0(25)	22	1.9(27)
Soccer	21	1.8(34)	5	.4(33)	2	.2(33)
Speedball	29	2.5(33)	4	.3(34)	2	.2(33)
Volleyball	117	10.0(25)	67	5.8(24)	30	2.6(24)
Folk and Square Dance	291	25.2(15)	191	16.6(11)	124	10.8(12)
International Dance	165	14.3(22)	71	6.1(23)	44	3.8(21)
Modern Dance	219	19.0(21)	107	9.3(17)	64	5.5(19)
Social Dance	311	27.0(13)	159	13.7(13)	176	15.2(10)
Tap and Clog Dance	231	20.0(19)	105	9.2(18)	75	6.5(18)
Basic Skills	38	3.3(31)	21	1.9(28)	14	1.2(28)
Body Mechanics	80	6.9(29)	18	1.5(30)	6	.5(31)
Conditioning	82	7.1(27)	37	3.2(27)	23	2.1(26)
Posture Correction	124	10.7(24)	11	1.0(31)	11	1.0(29)

[1] Numbers in parentheses give the ranks of activities.

Tennis ranks highest in desired instruction except at the advanced level where it is second to swimming. Golf, skiing, bowling, and riding rank high and approximately the same at all levels. Sailing and canoeing rank higher at the beginning level than at the intermediate and advanced levels, and archery ranks higher at the beginning and intermediate levels than at the

advanced. Swimming, badminton, and folk dancing rank higher at the intermediate and advanced levels than at the beginning, and social dancing ranks higher at the advanced than at either the intermediate or beginning level. Since the total desiring instruction at the three levels adds up to over 100 per cent for many activities, it is obvious that many students who desire to learn a new activity wish to pursue it beyond the beginning level. Again the activities in which the most students desire instruction are of an individual or dual nature and water sports rank high. Very few students desire instruction in soccer, speedball, and field hockey.

It is interesting to compare the activities in which students indicated a desire for instruction with those that they checked for inclusion in the program. Many are high on both lists (swimming, tennis, bowling, golf, diving, badminton, skiing). Sailing is much higher on the list of activities in which instruction is desired than on the list of activities that should be taught. On the other hand, 86 per cent of these students indicated that they feel posture correction should be included in the program but only a total of 12 per cent noted a desire for such instruction. Apparently students feel that it is worth including such a course for the small percentage that need it. Also over three-fourths of the students checked volleyball, basketball, and softball for inclusion in the program but relatively small percentages of students indicated any desire for instruction in these activities.

SCHEDULING PROBLEMS

Seventy-seven per cent of the students indicated that they had been able to register for activities that they wanted in college. Of those who had not been able to take activities of their first choice 88 per cent checked as the reason "came at the wrong hours," 77 per cent "sections closed," and 18 per cent "late registration date."

REACTION TO ACTIVITIES TAKEN IN COLLEGE

Sixty-nine per cent of those who had registered for an activity other than their first choice reported that they had liked the substituted course better than they had anticipated. Of those who did not, approximately half checked as the reason "dislike of the activity itself" and about one third "lack of success in the activity." Seventy-seven per cent of the students responded that they had liked the activity of their first choice as well as they had thought they would. Fourteen per cent answered that they had not and 9 per cent did not answer the question. Of those that replied that they had not liked the activity of their first choice, over half gave as the reason "lack of success in the activity." Two students added "didn't feel accomplishment" to the list.

PREVIOUS INSTRUCTION

Table 4 shows the percentage of students who had had instruction in the various activities in high school and out of school. Basketball, volleyball, and softball are by far the activities most taught in the high schools attended by these students. Folk and square dancing and badminton come next but

were checked by approximately 15 to 20 per cent less. Only badminton from this group is among the ten activities most desired in college. The activities in which these students had the least high school instruction are canoeing, fencing, and sailing. Less than 1 per cent indicated high school instruction in

TABLE 4

Number and Percentage of Students Who Have Had Instruction in Each Activity in High School and Out of School, or Are Now Participating Out of School

Activity	Instruction				Now Participating	
	High School		Out of School		Out of School	
	No.	Per cent	No.	Per cent	No.	Per cent
Archery	212	18.4	105	9.1	...	....
Badminton	673	58.3	127	11.0	330	28.6
Bowling	65	5.6	129	11.2	660	57.1
Canoeing	6	.5	143	12.4	210	18.2
Fencing	4	.3	6	.5	...	....
Golf	66	5.7	142	12.2	290	25.1
Riding	29	2.5	310	26.9	312	27.0
Sailing	5	.4	152	13.2	309	26.8
Skating, Ice	15	1.3	312	27.0	328	28.4
Skating, Roller	11	1.0	192	16.6	401	34.7
Skiing	38	3.3	434	37.6	544	47.1
Stunts and Tumbling	400	34.6	62	5.4	...	....
Tennis	452	39.1	198	17.1	577	50.0
Track and Field	87	7.5	15	1.3	...	....
Swimming	175	15.2	606	52.5	844	73.1
Diving	60	5.2	195	16.9	334	28.9
Rhythmic Swimming	25	2.2	62	5.4	...	....
Lifesaving	34	2.9	166	14.4	...	....
Water Safety Instruction	17	1.5	79	6.8	...	....
Basketball	963	83.4	71	6.1	109	9.4
Field Hockey	180	15.6	4	.3	...	....
Softball	855	74.0	81	7.0	242	21.0
Soccer	377	32.6	17	1.5	...	....
Speedball	168	14.5	3	.3	...	....
Volleyball	948	82.1	65	5.6	134	11.6
Folk and Square Dance	692	59.9	204	17.6	273	23.6
International Dance	64	5.5	63	5.5	...	....
Modern Dance	211	18.3	65	5.6	...	....
Social Dance	347	30.0	344	29.8	817	70.7
Tap and Clog Dance	76	6.6	213	18.4	...	....
Body Mechanics	389	33.7	15	1.3	...	....
Conditioning	198	17.1	10	.9	...	....
Posture Correction	228	19.7	40	3.5	...	....
Basic Skills	115	10.0	5	.4	...	....

these activities. Canoeing and sailing are among the ten top activities in which these students indicated a desire for college instruction.

The activities in which most of the students had had instruction out of school were swimming, skiing, social dancing, ice skating, and riding. Many students who had had instruction in certain activities out of school and in high school indicated a desire for more beginning instruction in these same activities. An analysis of these results suggests that:

1. Apparently agencies which are giving instruction in swimming are not developing swimmers of an intermediate level of ability.
2. The out-of-school agencies teaching skiing are not developing a satisfying level of skill in the brief courses that they offer.
3. The amount of tennis and badminton given in high school may be one factor in stimulating a desire for more beginning instruction in these activities.

RECREATIONAL PARTICIPATION OUT OF SCHOOL

Those activities in which over 5 per cent of the students reported engaging are also shown in Table 4. Swimming tops the list, with social dancing second. Such high interest in social dancing has not been indicated previously in the results of this study. However, this is probably explained by the number of dances attended by most university students and the fact that most of them feel that they have a satisfactory degree of skill and, therefore, do not desire instruction in this activity. Bowling, tennis, and skiing were also indicated as highly popular as out-of-school activities. In all, 17 activities were checked as being participated in by more than 9 per cent of these students. Eleven other activities listed on the questionnaire were checked by from 1 to 5 per cent. Eight were added by an equal percentage. Hiking was added to the questionnaire by approximately 7 per cent of the students. There were five activities listed that were checked by under 1 per cent and 21 others were added by an equally small percentage. Altogether these students indicated that they participate in a total of 62 different activities out of school.

REQUIREMENT

As in several previous studies, most of these students (80%) indicated that they favor a requirement in physical education. Of these, the majority favor a requirement of two years.

Approximately 60 per cent of the students indicated that they feel swimming should be a required course. However, in response to a question later in the questionnaire, more than 75 per cent checked that every student should be required to pass a swimming test before graduation. Though no specifications were suggested for such a test, 83 per cent of the students agreed that those who could pass a test should be exempt from a swimming course requirement. Other specific course requirements that were approved by 20 per cent or more of these students were dancing (26%), a team sport (26%), and individual sport (25%), and body conditioning (20%). Many addi-

tional activities were suggested by the students for requirement, but only posture correction was suggested by as many as 1 per cent.

ELECTIVES BEYOND THE REQUIREMENT

A total of 88 per cent of the students indicated that election of physical education courses beyond the requirement should be allowed. Sixty-five per cent felt that the number of courses to be elected should be unlimited and the majority (72%) stated that credit should be granted toward graduation for these elected courses.

LECTURES ON OBSERVATION OF SPORTS

Approximately half of the students indicated an interest in special lectures (outside of class) on football from the point of view of the spectator. About one-third reported an interest in basketball and a fifth in baseball. Twenty sports were added to this section of the questionnaire but none of them by more than 4 per cent of the students.

Summary and Conclusions

The principal objectives which these students claimed for their physical education experience are "to develop skills in various sports," "to learn activities that can be continued outside of school," "to have fun," and "to keep in good health and physical condition."

Of the courses not offered at the University of Washington at the time of this study, most students indicated that sailing,[2] ice skating, and posture correction should be included in the program.

Coeducational classes in more of the dance activities and individual or dual sports should be included in the physical education curriculum if student interests and needs are to be met. However, there are some activities in which the majority of students do not want coeducational instruction.

Students have a decided preference for the individual and dual sports and therefore, the majority of the program should be made up of these activities. However, since some students prefer team activities they should not be completely eliminated from the program. The program at the University of Washington is currently so constituted.

Since the chief reason advanced by the students for not liking a physical education class was lack of success, classes should be kept small enough to make individual attention possible, so that each student can be helped to set her own standards and to succeed up to her expectation and ability.

As the major reason for not being able to take first choice activities seems to be scheduling, schedules should be studied in light of the results of this study, and recommendations should be made to insure as many students as possible registering for preferred activities. As many sections as possible in the most desired activities should be scheduled and as many different hours of the day as possible should be used for these sections. Beginning, intermediate, and advanced sections need to be planned in light of the numbers of

[2]Sailing was offered on a limited trial basis, spring quarter, 1953.

students who indicated interest in the various levels of instruction. Although beginning instruction is clearly indicated in all activities, it is clear that there is a demand for more advanced instruction in several activities. Intermediate and advanced instruction is needed in tennis, golf, skiing, bowling, swimming, riding, and diving. This means considering the addition of sections in advanced tennis, intermediate and advanced golf, advanced riding, and intermediate and advanced diving.

For out-of-school recreation, students participate most in those activities in which they desire instruction in college.

The majority of students concur with the current policies of the University of Washington to require every student to pass a swimming test and to require physical education for two years. Contrary to current University policy, students feel that they should be allowed to elect, beyond the requirement, as many courses in physical education as they desire for credit toward graduation.

Lectures on the intelligent observation of football and basketball are desired by sufficient numbers to warrant consideration of such an addition to the program.

(Submitted 11-8-53

Comparison of Instruments for Recording Muscle Strength[1]

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Abstract

This study compared the effectiveness of the following four instruments for recording muscle strength: cable tensiometer, Wakim-Porter strain gauge, spring scale, and Newman myometer. As reflected by objectivity coefficients, the cable tensiometer had the greatest precision for strength testing. It was the most stable and generally useful of the instruments; and was free of most of the faults of the other devices. The strain gauge had a satisfactory degree of precision; but was extremely sensitive to slight tensions, including changes in room temperature. Both the spring scale and the Newman myometer had deficiencies which limited their usefulness.

AN EARLIER STUDY was conducted in the Physical Education Laboratory at Springfield College to compare the effectiveness of the following instruments for recording muscle strength by the cable-tension method: cable tensiometer, Wakim-Porter strain gauge, spring scale, and Newman myometer (3, 7). Comparative trials of these devices were made with strength tests of weak and strong intensities. The results were as follows:

1. *Cable Tensiometer.* The objectivity coefficients[2] for the tests obtained with the tensiometer varied between .90 and .95. The precision thus indicated was consistently higher than for the other instruments.

2. *Wakim-Porter Strain Gauge.* Satisfactory objectivity was obtained with the strain gauge. It was generally superior to the cable tensiometer in the amount of strength recorded. However, some inconsistency was found in the results, in that the superiority of the strain gauge was definite with the weaker strength performances, but approximately the same as the tensiometer in the stronger strength movements. In studies completed at the Mayo Clinic, Wakim and associates (8) reported that their strain gauge had higher readings than the cable tensiometer in 183 of 200 strength tests of the elbow flexor muscles, the average difference being 4.1 pounds. The strength-testing techniques were the same as those developed in the Springfield laboratory.

3. *Spring Scale.* Objectivity coefficients in using the spring scale for strength testing were found to be high, .85 and .89 for two tests. However, this instrument was significantly inferior to both the tensiometer and the strain gauge in the amount of strength recorded.

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[1]Acknowledgments are made to Theodore L. Bailey and Donald K. Mathews, who served as laboratory supervisors during the various periods of the study.

[2]Objectivity coefficients are coefficients of correlation obtained from correlating test-retest results utilizing different testers.

4. *Newman Myometer.* Limited to strength efforts not exceeding 60 pounds, initial experience with the myometer resulted in extremely low objectivity coefficients for the tests included with this instrument.

Owing to some inconsistencies in the results obtained in this earlier study, to certain inadequacies in the techniques (especially lack of uniform calibration of the instruments), and to dissatisfaction with the manner in which the myometer was used, a re-evaluation of the instruments utilized for recording strength test scores was undertaken. (1) The evaluation of the instruments was based upon the following three factors: (a) the degree of agreement between the results obtained by different testers, as indicated by objectivity correlations; (b) a comparison of the mean pounds recorded by the instruments for the same strength tests; and (c) the amount of correlation between the results recorded by the instruments on the same tests.

Testing Instruments

The same four testing instruments for recording muscle strength were used in this study as reported above: cable tensiometer, Wakim-Porter strain gauge, spring scale, and Newman myometer. An especially designed device for calibrating the instruments was obtained from the manufacturer of the cable tensiometer.[3] This calibrator is equipped with a standard spring dynamometer of proven accuracy. A standard aircraft cable, size 1/16 inch (of the same type used in the strength testing), is arranged between the crank tightener and the dynamometer. Tension is produced on the cable by turning the crank and is recorded on the dial of the dynamometer.

With the exception of the myometer, all testing instruments were calibrated with this device, so as to secure uniform calibration among the instruments to be evaluated. Such calibration was particularly important for the strain gauge, as, otherwise, it would have been necessary to calibrate it by hanging weights from the cable, a method which quite possibly might be open to some error.

Descriptions of the testing instruments and their methods of calibration appear below.

Cable tensiometer (Figure I). The cable tensiometer was originally designed to measure the tension of aircraft control cable. Cable tension is determined from the force needed to create offset on a riser in a cable stretched between two set points, or sectors. This tension can be converted directly into pounds on a calibration chart.

As the calibrator was designed for the cable tensiometer, calibration of this instrument presented no problem. The tensiometer was placed and held on the cable; tension was applied by turning the handle of the calibrator. A reading in pounds was taken from the dynamometer for every increase of one unit on the tensiometer dial, from 1 to 100.

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[3]Model C-105-3. Pacific Scientific Company, 1430 Grande Vista Ave., Los Angeles, California.

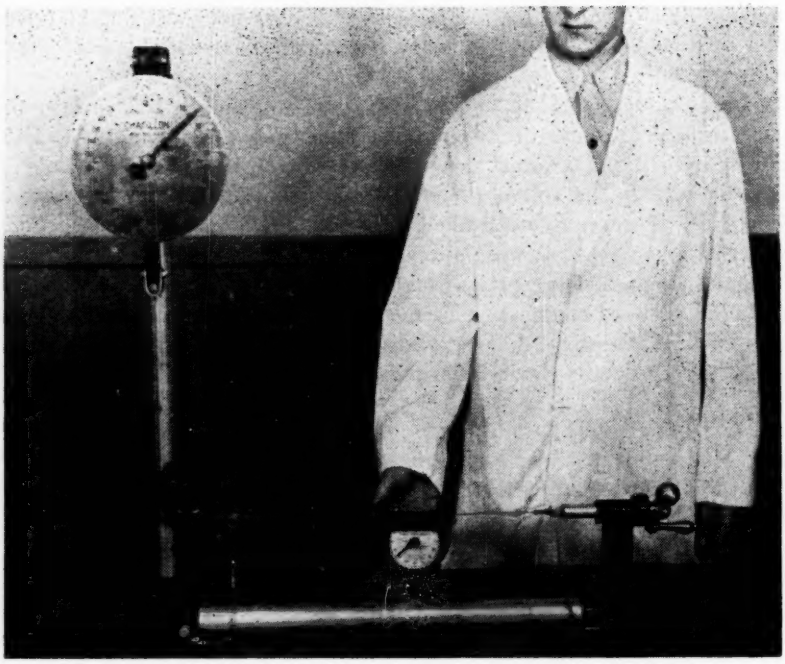

FIGURE 1. Cable Tensiometer Calibration.

Watkim-Porter strain gauge (Figure II). Of the four elements of the strain gauge, two were attached to the outer side and two to the inner side of an aluminum alloy ring which was approximately 4 cm. in diameter and 2.6 mm. in thickness. The ring was covered with a protecting layer of friction tape.[4] The elements were connected by four separate wires to complete a circuit containing a galvonometer, a battery, and a 20-watt bulb. For testing, the ring was connected to one end of the cable-tension pulling assembly; the other end was hung on the appropriate hook for a given test.

The galvonometer, battery, light, and a frosted plastic scale were mounted on a plywood board, 5 ft. x 2.5 ft.; and were located in a dark room adjacent to the testing area. Changes of resistance on the strain gauge produced deflections in the galvonometer. Two "slivers" of light were produced by the light reflection from the galvonometer, which were reflected in turn on the frosted plastic scale: one of these remained fixed at a zero point; the other deflected with the amount of resistance produced on the ring. The scale was marked off in millimeters, from which the amount of strength exerted in testing could be determined.

In calibrating, the strain gauge was connected to the calibrator by means of

[4]Acknowledgments are made to Dr. Khalil G. Wakim and A. N. Porter, Mayo Clinic, for the construction of the strain gauge element used in the study.

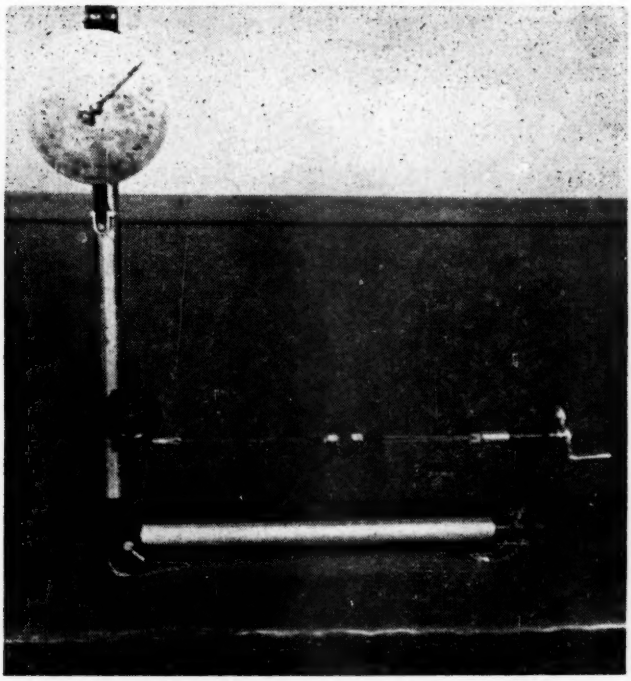

FIGURE II. Calibration with Strain Gauge Ring.

1/16 inch cable. An initial reading of zero was taken. Tension was then applied and readings in pounds were taken from the dynamometer for each movement of 2 mm. on the scale.

Early in the study, the aluminum ring used in the construction of the strain gauge was found to be sufficiently sensitive to differences in room temperature as to cause different zero readings each day. As a consequence, an initial calibration reading for this scale was taken before testing commenced each day; and the scoring units adjusted throughout in accordance with any deviations found.

Spring scale (Figure III). An ordinary spring scale, calibrated in pounds from zero to 100, was used in the study. A ring was located at each end of the scale to permit attachment between the wall hook and the cable-tension pulling assembly. A maximum indicator was added which slid freely with the pointer on the scale and remained stationary at the farthest point reached in a pull.

To calibrate, the spring scale was connected to the calibrator by means of wire, as shown in the illustration. Again, pressure was applied by turning the handle of the calibrator. However, the relatively large movement of the spring scale's testing unit when applying tension permitted motion beyond the limit of the calibrator. For this reason, the scale could only be calibrated to 60 pounds. As the readings on the spring scale corresponded with those of

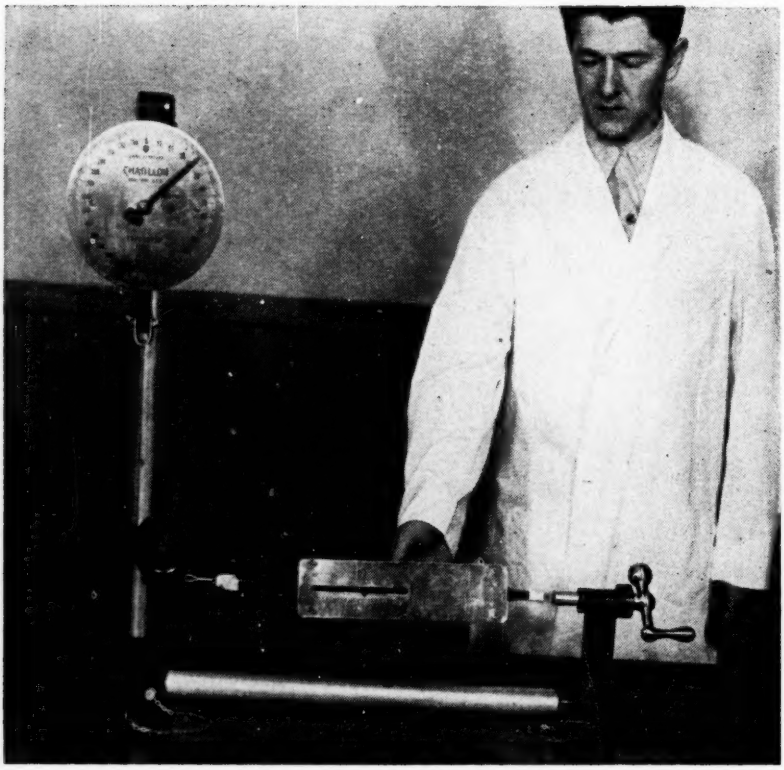

FIGURE III. Spring Scale Calibration.

the dynamometer up to 60 pounds, further calibration was considered unnecessary.

Newman myometer (Figure IV). The myometer (6) consists of a cylindrical housing 2 inches in diameter and 3¼ inches long, which encloses the complete mechanism. Extending from one end is a shaft with a pressure transmitting button. Enclosed at the other end, and visible through a transparent plastic cover, is a dial gauge. This gauge has a maximum reading pointer that remains at the farthest point on each test until it is manually reset to zero. A built-in hydraulic pressure converter transmits the linear force exerted on the but on to the pressure gauge. Two such instruments are provided with each set with the following ranges: 0 to 15 pounds; and 0 to 60 pounds.[5] In testing for muscle strength with the myometer, the tester pushes the transmitting button against the body part acting as lever; the score is recorded at the point where the subject "breaks," i.e., is unable to resist the amount of pressure applied and gives way.

[5]On trial in strength testing, the myometer obtained from the factory for this study did not permit tests beyond 48 pounds.

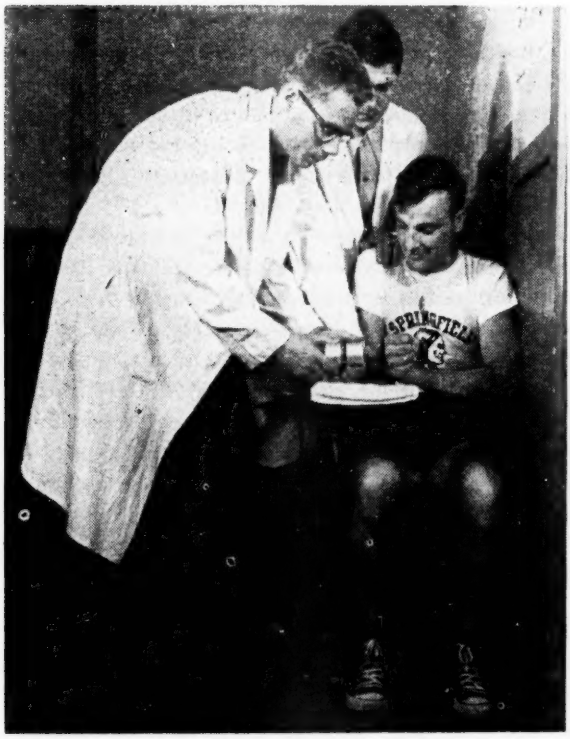

FIGURE IV. Testing Wrist Dorsal Flexion with Newman Myometer.

Calibration of the myometer with the calibrator used for the other recording instruments was not possible, as the calibrator is designed for a pull rather than for the push technique of the myometer. The calibration of the myometer, however, was considered reliable, since the instrument was new and had been calibrated before leaving the factory.

Procedures

STRENGTH TESTS

Six strength tests were selected for the purpose of the study. So as to check the effectiveness of the instruments for weak and for strong muscular exertions, the following strength tests were included:

Weak movements: finger flexion, wrist dorsal flexion, shoulder outward rotation, and neck extension.

Strong movements: knee extension and ankle plantar flexion.

The strength tests were the same as for the earlier study, with the following exceptions: (a) Ankle plantar flexion replaced trunk flexion, in order to eliminate adjustment for a gravity factor. (b) The strength test of the knee extensor muscles was added, so as to provide two tests with strong movements. The strength testing techniques were the same as described by Clarke. (2)

TESTERS

The testers were three graduate students in physical education at Springfield College.[6] These testers were instructed in and practiced the various testing techniques. Before allowing test scores to be included in the research data, they were required to demonstrate testing competence by obtaining an objectivity coefficient for each test which was equal to that formerly reported for the test.

Special care was exercised in mastering the technique of testing with the myometer. The testers practiced repeatedly with this instrument in order to obtain the highest possible degree of agreement. Also, for wrist dorsal flexion, the arm-rest chair used in the test was placed against the wall in such a manner as to permit the subject's free forearm to serve as a brace between the wall and the forearm of the wrist being tested (Figure IV). Thus, any "break" or movement away from the myometer as pressure was applied was confined to the wrist and did not include the forearm.

COLLECTION OF TEST DATA

Inasmuch as certain of the testing instruments had limitations in the amount they could record (100 pounds for the spring scale; 48 pounds for the myometer), all devices could not be used for all strength tests. As a consequence, the following distribution was adopted:

Tensiometer and strain gauge: all six tests.

Spring scale: neck extension and shoulder outward rotation tests.

Myometer: finger flexion and wrist dorsal flexion tests.

The subjects were 64 male students at Springfield College. In order to minimize the effect of muscle fatigue caused by taking repeated strength tests, the following process was followed. (a) Four subjects were given all strength tests with the four instruments during a single testing session; (b) For each instrument, all strength tests were given twice consecutively by different testers; (c) Each subject was then permitted to rest, while the others were being tested, before repeating the tests with a different instrument. The cable tensiometer and the strain gauge were used simultaneously for the various tests, i.e., readings with both instruments were taken from the same pull.

STATISTICAL TREATMENT OF TEST DATA

In the statistical treatment of the test data, three procedures were followed, as described below:

1. *Objectivity Coefficients.* Objectivity coefficients, in the form of coefficients of correlation between each pair of scores obtained by different testers on each test for each instrument, were computed. A comparison of these coefficients was made in order to determine the relative accuracy of the recording devices. Coefficients of .90 and above are indicative of desired precision, while coefficients as low as .80 are considered usable for individual measurement.

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[6]Acknowledgments are made to Alfred E. Chrzan, Gordon M. Gibson, and G. Barry Thompson.

2. *Comparison of Means.* As the original research with cable-tension strength tests was done with the cable tensiometer, the scores recorded with this instrument were used as a basis of reference for those obtained with other devices. In each case, the mean in pounds recorded for each strength test with each instrument was computed. The difference between the means for each test was tested for significance by the null hypothesis[7] based upon "students" distribution. (4) On this basis, t's of 1.67 and 2.37 denote significance for 64 cases at the .05 and .01 levels of confidence respectively. (5) These t's were chosen because differences were measured from no difference in one direction only, thus *P* was halved. In explanation, the chances are 95 in 100 that there is statistical significance between means at the .05 level, a difference which cannot be accounted for by sampling errors; at the .01 level, the chances are 99 in 100 that this is true.

3. *Instrument Inter-Correlations.* The results obtained with the different recording instruments on the same tests were inter-correlated in order to determine the degree of agreement between them throughout the range of scores.

Instrument Objectivity

Objectivity coefficients, indicating the precision with which the various testing instruments can be used to record the maximum muscular strength of the subjects appear in Table 1.

TABLE 1

Objectivity Coefficients of the Four Recording Instruments As Applied to Six Selected Strength Tests

Strength Tests	Cable Tensiometer	Strain Gauge	Spring Scale	Newman Myometer
Weak Movements				
Finger Flexion	.90	.94		.82
Wrist Dorsal Flexion	.92	.85		.79
Shoulder Outward Rotation	.91	.91	.91	
Neck Extension	.92	.87	.97	
Strong Movements				
Knee Extension	.96	.81		
Ankle Plantar Flexion	.94	.94		

As was true in the earlier study, the cable tensiometer proved to be the most consistent of the four recording devices investigated. The objectivity coefficients for this instrument were between .90 and .96. They were equal to or higher than the coefficients for the others in all but two of the strength tests: for finger flexion, the strain gauge (.94) exceeded the tensiometer (.90); and for neck extension, the spring scale (.97) was higher than the tensiometer (.92).

[7]The formula used in determining the standard error of the difference was for correlated means, as this study is in the nature of a one-group experiment.

In general, the objectivity coefficients for the strain gauge were satisfactory. However, some difficulty was encountered in handling this instrument effectively in the laboratory, as is evidenced by the three coefficients of .81, .85, and .87. The strain gauge was much more sensitive to slight changes in tension, even to the point of being affected by room temperature, as pointed out in the description of the calibration process.

In connection with the strain gauge, too, it should be pointed out that the tension readings were taken visually from a frosted scale. At the Mayo Clinic, Dr. Wakim recorded the performance on photostat paper, exposed by the "sliver" of light from the galvonometer. With the more objective Mayo technique, higher objectivity coefficients may be achievable.

The objectivity coefficients for the spring scale were satisfactory, being comparable to the tensiometer in the tests with which it was used. The coefficient of .97 for neck extension was the highest obtained in the study. These high coefficients were unexpected, as it was thought initially that awkwardness in handling the clumsy spring scale in strength testing would negate against its precision.

Results with the Newman myometer were much better than in the earlier investigation. The objectivity coefficients were .79 and .82 as compard with .20 and .34. However, these coefficients were the lowest obtained with any of the instruments evaluated.

Mean Strength Records

In the following comparisons of mean pounds of strength recorded by the four recording instruments, the mean for the cable tensiometer was taken as the basis of reference for the others.

STRAIN GAUGE

The strain gauge was used with all six strength tests. The results of testing with this device as compared with the tensiometer are presented in Table 2.

TABLE 2

Comparison of Mean Pounds of Strength Recorded by the Wakim-Porter Strain Gauge and the Cable Tensiometer

Strength Test	Means		Diff. Means	S.E. of Diff.	t
	Tensiometer	Strain Gauge			
Weak Movements					
Finger Flexion	36.23	43.71	+ 7.48	2.20	3.40
Wrist Dorsal Flexion	44.50	44.54	+ .04	1.49	.03
Shoulder Outward Rotation	47.98	48.35	+ .37	1.64	.22
Neck Extension	54.82	59.14	+ 4.32	1.71	2.52
Strong Movements					
Knee Extension	237.30	224.50	−12.80	2.78	4.60
Ankle Plantar Flexion	224.00	216.70	− 7.30	2.37	3.08

In the strong strength tests, the tensiometer was definitely superior to the strain gauge in the amount of strength recorded. For knee flexion, the dif-

ference between the mean pounds pulled by the subjects was 12.8; and for ankle plantar flexion, the difference was 7.3. The t's of 4.60 and 3.08 are statistically significant beyond the .01 level of confidence.

For the weaker movements, the superiority of the instruments is not decisive. The strain gauge produced higher means for two tests, finger flexion and neck extension; the t's were 3.40 and 2.50, denoting statistical significance at and beyond the .01 level. For the other two weak movements, wrist dorsal flexion and shoulder outward rotation, however, no appreciable differences were found.

SPRING SCALE

The spring scale was used with two of the strength tests only. The results of testing with this device as compared with the tensiometer appear in Table 3.

TABLE 3

Comparison of Mean Pounds of Strength Recorded by the Spring Scale and the Cable Tensiometer

Strength Test	Means		Diff. Means	S.E. of Diff.	t
	Tensiometer	Spring Scale			
Shoulder Outward Rotation	47.98	42.66	—5.32	.85	6.24
Neck Extension	54.82	50.42	—4.40	.82	5.37

The mean-pounds pull with the tensiometer was definitely higher than with the spring scale when testing for the weak strength movements of shoulder outward rotation and neck extension. The t's of 6.24 and 5.37 indicate statistical significance well beyond the .01 level of confidence.

MYOMETER

As the testing range of the myometer is limited to 60 pounds, it could be used with only two of the strength tests, finger flexion and wrist dorsal flexion, without causing truncated distributions. The mean results with this instrument as compared with the tensiometer are given in Table 4.

TABLE 4

Comparison of Mean Pounds of Strength Recorded by the Newman Myometer and the Cable Tensiometer

Strength Test	Means		Diff. Means	S.E. of Diff.	t
	Tensiometer	Myometer			
Finger Flexion	36.23	18.98	—17.35	1.05	16.52
Wrist Dorsal Flexion	44.50	40.16	— 4.34	1.11	3.90

For both finger flexion and wrist dorsal flexion strength tests, the mean pounds recorded was greater when the tensiometer was used. With finger flexion, this difference was very pronounced: 36.23 pounds with the tensiometer and 18.98 pounds with the myometer, a difference of 17.35 pounds,

or 91 per cent. This greater difference may have been due to difficulty in applying the myometer to the index finger. It was necessary to maintain the non-test fingers in an extended position in order to prevent their interference with the downward pressure of the myometer on the test finger. In the cable tension method, the non-test fingers were permitted to flex at will.

The mean for the wrist dorsal flexion strength test was 4.34 pounds greater when the tensiometer was used. The t of 3.90 is significant beyond the .01 level of confidence.

CORRELATIONS OF CABLE TENSIOMETER WITH OTHER INSTRUMENTS

The correlations of the results obtained with the tensiometer and the other recording instruments are presented in Table 5. A summary of these data is as follows:

1. The correlations between the results obtained with the tensiometer and the strain gauge were extremely low for the weak strength tests, ranging from .14 to .43. As the movements became stronger, the correlations became higher. Neck extension, the strongest of the four strength tests in the weak classification, had the highest correlation in this group. The results with the strong movements were much more satisfactory, with correlations of .89 and .90 for knee extension and ankle plantar flexion.

2. The spring scale results were correlated with those for the tensiometer on two of the weaker movements. The correlation coefficients were .58 and .80 for shoulder outward rotation and neck extension respectively. In this situation, the coefficient of .80 is considered fair and .58 unsatisfactory, as indicators of testing consistency between the two instruments.

3. The correlation coefficients obtained between the tensiometer and myometer results were .14 and .36 for finger flexion and wrist dorsal flexion respectively. When the myometer results were correlated with the strain gauge scores for the same tests, the coefficients were similar: .28 for finger flexion and .08 for wrist dorsal flexion.

TABLE 5

Correlations of Results Obtained with the Tensiometer and with the Other Instruments for the Various Strength Tests

Strength Test	Tensiometer with		
	Strain Gauge	Spring Scale	Myometer
Weak Movements			
Finger Flexion	.14		.14
Wrist Dorsal Flexion	.24		.36
Shoulder Outward Rotation	.33	.58	
Neck Extension	.43	.80	
Strong Movements			
Knee Extension	.89		
Ankle Plantar Flexion	.90		

Discussion

A number of conditions present in the testing situation need to be considered in the proper understanding and interpretation of the results of this study. Such a discussion is presented below:

TENSIOMETER AND STRAIN GAUGE

In contrasting the results obtained in strength testing with the tensiometer and the strain gauge, the two major recording instruments in the study, certain inconsistencies are apparent, as was true in the earlier instrument evaluation. *First,* the tensiometer was the more consistent instrument for all tests, as indicated by objectivity coefficients; however, the strain gauge showed the same precision as the tensiometer for some tests but was lower for others. *Second,* for some tests, the strain gauge produced a higher mean in pounds pulled, while in others the tensiometer was superior. The tensiometer had a definite advantage in the strong pulls; for the weak pulls, the strain gauge was best with two tests, but there was no significant difference for the other two tests. *Third,* the correlations between the results obtained with these two instruments were high for the strong movements and low for the weak movements, despite the fact that both test records were made simultaneously on the same pull each time. The following factors may account, in part at least, for these discrepancies:

1. The strain gauge is a much more sensitive instrument than is the tensiometer. It responds more quickly to slight changes in tension. As was pointed out in the consideration of instrument calibration, this sensitivity was demonstrated quite clearly in the effect of room temperature on the strain gauge readings each day.
2. Much greater variability of scores for the weak strength tests was found with the strain gauge as contrasted with the tensiometer. As a consequence, slight changes in tensiometer records affected their location on the correlation scattergram in greater degree than for the more variable strain gauge scores.
3. With strong strength tests, the aluminum ring used in the construction of the strain gauge was distorted and returned slowly to its original shape, as shown by continued tension reflected from the galvonometer on the frosted scale. In the sequence of testing in this study, weak strength tests followed strong movements; as a consequence, the strain on the ring from heavy pulls, averaging 224 and 237 pounds, may have interfered with the accuracy of the subsequent lighter tests.

TENSIOMETER AND SPRING SCALE

The differences in the results obtained between the tensiometer and spring scale are attributed to the pronounced movement of the spring scale testing unit when tension is applied. This movement permits the subject's joint to move beyond the degrees specified for each test. Also, such movement allows a change in the 90-degree angle of pull required of all tests. These changes vary with the amount of strength applied. Thus, the stronger subjects pulled

into a weaker test position, i.e., a weaker position for the muscles to apply tension. With the tensiometer, these angles are reasonably well stabilized for all subjects, thus maintaining this factor as a constant for all subjects regardless of their strength.

TENSIOMETER AND MYOMETER

A factor which should be kept clearly in mind when considering the strength testing results with the myometer is that it operates on the "break" principle, i.e., the muscles resist force (isometric contraction) applied by the tester until they can no longer do so and, hence, give way before the pressure applied. For the other three recording instruments, the strength test is based upon a direct pull by the muscles on a cable (isotonic contraction). The relationship between the amounts of isometric and isotonic contractions for the same muscle groups has not yet been established. However, the change in the testing process may have affected the results when a direct comparison is made.

The variability of the scores obtained with the strain gauge was three to four times greater when the strain gauge was used than with the myometer. The standard deviations for the scores obtained with the strain gauge were identical (17.66) for both finger flexion and wrist dorsal flexion strength tests; while with the myometer, the standard deviations for the same tests were 5.67 and 4.60 respectively. Thus, where correlations are computed, the myometer suffers from a narrow range of scores in much the same way as discussed above for the tensiometer.

Conclusions

An over-all evaluation of the four instruments studied for recording muscle strength is as follows:

Cable Tensiometer. As reflected by objectivity coefficients, the cable tensiometer had the greatest precision for strength testing. It was the most stable and generally useful of the instruments; and was free of most of the faults of the other devices. A narrow range of scores for the weak strength tests, as contrasted with the strain gauge, was found.

Wakim-Porter Strain Gauge. The strain gauge had a satisfactory degree of precision in strength testing. However, it is extremely sensitive to slight tensions, including changes in room temperature; and permits distortion of the aluminum ring used in its construction when strong strength tests are administered, with slow return to its original shape.

Spring Scale. The spring scale used was limited to 100 pounds; heavier scales could be used but would probably be increasingly awkward and insensitive to weak strength tests. The objectivity coefficients are satisfactory. A serious fault of this instrument is the amount of movement of the testing unit when tension is applied, which allows the specified joint angle and the angle of pull to change. Thus, lower scores result, differing proportionately from subject to subject depending upon their strength.

Newman Myometer. The use of the myometer is based upon resistance to pressure rather than the application of tension by pulling. By construction, it is limited to 60 pounds; greater resistance would probably cause fatigue of the testers and bruising of the subjects. Objectivity coefficients are fairly high, when testers are carefully trained and test with great care. Mean scores with this instrument are significantly lower than for the other recording devices.

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A Factorial Analysis of Motor Co-ordination

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Abstract

Part I. The multiple-group method of factoring was used to extract eight factors from the intercorrelations of 21 variables that had been used in the past to measure some phase of motor co-ordination. Five of the factors (balancing objects, tempo, two-handed agility, speed of change of direction of the arms and hands, and body balance) permitted rather clear interpretation. Factors E, G, and H were left unnamed and need further clarification.

Part II. A comparison of the centroid and the multiple-group methods of factoring the same data was made. A least squares approximation of the F matrix from the V matrix was made. It was shown, that for all practical purposes, the two methods yield similar solutions when the same communalities are used in both solutions.

PART I

The Analysis of Motor Co-ordination Variables

DIAGNOSIS AND prognosis of individual differences in human behavior have been a matter of keen concern for psychologists and educators for years. In an effort to get a clear understanding of these human differences, certain words, indicative of concepts, have been employed. These concepts about human behavior are, in essence, abstractions. They have not been measured directly.

One is faced, however, with the actuality, that these "named" concepts about human behavior have different meanings for different people. The different meanings have led to widely scattered and diversified selection of tests to measure the traits or abilities believed to be involved. The tests used to measure motor co-ordination have covered such abilities as throwing a ball, balancing a rod, hopping on one foot, holding the balance on tip toes, and patting the head and rubbing the stomach. In the absence of an agreed-upon definition of motor co-ordination, these tests have been used and listed as measures of co-ordination. The mere name-assigning of co-ordination to those tests, however, does not insure their validity.

[1]The author wishes to thank Professor Emeritus T. L. Torgerson for his advice and guidance throughout the author's graduate work; Professor Chester W. Harris of the School of Education, for his generous expert advice in the application of the factor analysis technique as well as for statistical advice in handling the data in Part II; also the Computing Service of the University of Wisconsin for running the correlation coefficients on the IBM machines.

Perhaps, in the interest of reaching some agreement, it might be wise to ascertain what these "co-ordination" tests really measure. Such a procedure is not concerned with first establishing a valid criterion for "co-ordination." Rather, it is concerned with the location of what is really being measured by a selected but diversified group of tests which claim to measure the same complex concept. It is essentially the type study which Thurstone (27) did with tests which claimed to measure intelligence. If the presence of what is being measured can be demonstrated, then perhaps workers in the field can agree upon an operational definition of motor co-ordination. Criteria may then be established, and tests devised for diagnosis and prognosis of individual weaknesses in motor co-ordination.

The Problem

Background of the Problem. Factor analysis has been used to explore a wide variety of motor skills tests in an effort to determine the underlying factors in motor ability. One of the first studies in physical education employing the factor technique was the one by Jones (13) using the tetrad difference criterion in an effort to locate a general motor ability similar to the Spearman "g" (23) in intelligence. Jones concluded that the emphasis should be on "abilities" rather than "ability."

A number of the studies since that time have been exploratory (3, 4, 6, 14, 15, 16, 17, 18, 28). The workers were looking for rather large dimensions such as strength, speed, co-ordination, endurance, rhythm, and balance as factors in motor ability.

Out of some 36 factors located in these studies 13 factors center around some form of co-ordination. The items appearing on these 13 factors indicate the following variables: throwing, kicking, catching, striking, ball handling, running, jumping, Johnson motor educability items, quick change of direction items, and a few composite scores.

While the exploratory studies so far have not given a clear definition of motor co-ordination, other workers have tested certain hypotheses about co-ordination. For example, H. G. Seashore (20) reported a study in which he attempted to locate some factor common to fine and gross co-ordinations. His analysis, however, showed no factors which had items of both fine and gross co-ordination. An excellent logical analysis of elements in fine co-ordinations has been made by R. H. Seashore (22). Later, R. H. Seashore, Dudek, Holtzman (21) proposed the hypothesis of a steadiness factor in fine co-ordination. Rather than locating one factor of steadiness, they located a factor which seemed to indicate static steadiness, and another factor which seemed to indicate steadiness when the subjects were moving. So, testing of these hypotheses about fine and gross co-ordination and about steadiness as a factor in fine co-ordination still leaves many questions.

Earlier workers in the field of motor ability offer some interesting clues. Oseretsky (7) made use of such items as rod balance, two-handed co-ordinations, speed of movement of the arms and hands, balance, hop and jump,

and to a certain degree, rhythm. Garfiel (8) made use of two-handed trick-type co-ordinations such as rubbing the stomach and patting the head, some measure of rhythm, tapping for speed, a ball toss at a target, and an item which would involve balance to successfully perform.

Thus, it seems that a combination of some of these items used by earlier workers and some of the items appearing on "co-ordination" factors in more recent studies offer interesting possibilities for a definition of motor co-ordination. Earlier workers in the field have been concerned with balance, both the balancing of objects and body balance. Consideration has been given in earlier work to the "rhythm" with which a person performed activities. It is conceivable that a person's ability to time his movements plays a major role in being "well-co-ordinated." In addition, the ability to change directions rapidly has been used by earlier workers and by more recent workers. To perform sports skills in a "co-ordinated" fashion, this ability seems important also.

The Problem and the Hypotheses To Be Tested. The problem of what factors are present in variables which have been used in the past as measures of some phase of "co-ordination" will be investigated. Two hypotheses will be tested:

1. There are definable factors in tests which claim to measure motor co-ordination.
2. Tests used to measure motor co-ordination group themselves around such factors as: the ability to balance objects and maintain body balance, the ability to time movements of the body, and the ability to move rapidly with the moving parts changing directions.

Procedure

The data for the 21 variables[2] were collected for 200 college Freshmen women with 92 per cent visual acuity, binocular efficiency, and depth perception at far-point as measured by the Keystone telebinocular. The tests were administered a second time from 80 to 130 students in order that test-retest reliabilities[3] could be determined. Scores of the 21 variables were used to calculate the Pearson product-moment correlations. These coefficients were calculated on punched-card equipment by the Computing Service of the University of Wisconsin. The 210 intercorrelations made up the entries in the original correlation matrix, Table 1.

The centroid and the multiple-group method of factoring were used to determine the underlying factors. Dissatisfaction with the rotations and with the appearance of the residual matrix[4] after the extraction of nine factors by the centroid method resulted in changing to the multiple-group method of factoring. Formulas and calculation procedures for the multiple-group method

[2]See list of variables in Table 2, page 417.

[3]Test-retest reliabilities are given in Table 2.

[4]See Table 4, page 423, for doublets remaining after the extraction of 9 centroid factors.

TABLE 1

Original Correlation Matrix (r) and Residuals[1]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1		-001	-024	010	-016	024	-010	-010	-003	003	003	-003	-013	-015	004	008	016	-017	-025	038	054
2	594		058	-039	001	-041	-005	038	002	-002	-003	003	-007	029	-010	-005	000	001	031	-001	-041
3	473	670		028	015	017	012	-029	012	-012	000	000	021	-013	008	000	-016	016	-005	-036	-011
4	278	356	334		049	002	-060	002	-002	002	000	000	-009	-018	009	-001	013	-013	-005	018	-018
5	212	298	249	362		075	-012	-049	008	-008	-005	005	-032	-006	050	006	-038	039	011	-041	-029
6	088	-026	014	046	135		016	-002	-038	038	-001	001	080	005	-034	015	014	-013	-070	006	-035
7	088	110	049	-003	059	258		061	043	-043	009	-009	-031	-007	030	-028	-007	006	050	040	012
8	-037	041	-068	183	003	106	164		003	-003	008	-008	010	019	-010	001	-013	014	005	-017	017
9	067	042	037	088	112	029	150	-044		001	026	-027	003	-026	-034	049	015	-016	031	-029	-003
10	065	052	022	162	152	041	-035	-030	300		-027	026	-004	026	034	-049	-015	016	-031	028	002
11	175	149	132	182	293	129	120	092	147	129		025	-020	-032	-012	018	-013	014	000	031	051
12	126	129	105	100	185	-014	-041	061	040	156	326		019	031	012	-018	012	-013	002	-031	-052
13	180	177	196	186	149	159	044	-038	124	117	175	117		073	-052	-067	-007	008	039	015	022
14	277	254	242	219	151	153	097	-008	085	108	145	042	317		-018	024	-007	006	-011	049	062
15	364	369	349	364	304	107	146	106	-016	062	268	178	183	352		073	011	-010	-046	-026	004
16	394	385	382	365	227	073	000	008	138	050	243	123	204	474	530		010	-009	-009	-009	-023
17	288	358	288	395	206	099	109	078	038	-022	251	164	244	352	464	504		000	033	-016	027
18	213	337	292	309	292	000	061	037	022	054	235	120	207	245	311	353	496		-034	015	-027
19	091	163	146	441	289	000	052	110	071	098	156	-047	221	288	239	289	292	189		058	061
20	185	175	139	302	281	026	031	-033	049	181	285	070	195	247	191	217	206	260	429		-019
21	274	137	203	269	189	006	-013	026	090	149	281	085	239	396	327	373	340	215	382	241	

[1]Residuals are underlined. Decimal points have been omitted.

of factoring as well as the outline of a technique for rotating the initial oblique solution to the primary solutions as given by C. W. Harris and Schmid (10) were followed.

Discussion of Data

Interpretations of Factors. Table 2, the Oblique Factor Matrix, will be used to discuss the eight factors extracted. Factor A clearly is a *balance* factor. In view of the loadings of the three balancing-objects items, it would appear that one may give to this factor the name of *balancing objects.* This appears to be the first time when items of the balancing-objects type have been included in a factorial analysis in the field of physical education. However, the ability to balance a rod on the index finger has seemed important as a measure of co-ordination by such people as Oseretsky, even though such skills have not been included in a factor analysis. Moreover, this factor is correlated with Factor E which is loaded heavily with the sports skills.

Factor B may be given the name *tempo.* The three highest items on this factor are those which required the subject to do a prescribed exercise in any tempo she liked, then repeat this tempo four more times. Allowing a student to perform at a preferred tempo in activities is the type activity Rimoldi (19) used for the majority of the tests in his personal tempo experiment. Rhythm has been exceedingly hard to measure objectively. This attempt to measure one phase of it (tempo) objectively still needs refinement. The test-retest reliabilities of these items were lower than those of other variables in the analysis, as may be seen in Table 2. Consequently, too great a dependence upon these items on this factor is not justified. Reference to the communalities in the same table, however, indicates that the variance accounted for is under the reliability estimates.

Factor C seems to be *two-handed agility.* The two variables which are high on this variable are the type tests which earlier workers in the field, Garfiel (8) and Oseretsky (7) seemed to consider important in co-ordination. The Army Air Corps (1) also used some two-handed variables in assessing the level of co-ordination of pilots. In all these two-handed variables, there seems to be some need for the subject to grasp or understand the situation before the motor operation can be put into practice. It would be interesting to see if variables which involved asymmetric movement of arms and legs would appear on this factor.

Factor D may readily be called *speed of change of direction of arms and hands.* Items 11 and 12 were designed to see how rapidly a person could move his arms and hands while performing a task which did not call for minute accuracy. The appearance of the static balance item on this factor is interesting. The subjects were seated on the floor while taking tests 11 and 12. There were no specified directions for the way the subjects were to sit. A large portion of the students leaned on one arm for support while taking the tests. This is a type of static balance and possibly had something to do with the performance on tests 11 and 12.

TABLE 2
Oblique Factor Matrix—V[1]

	A	B	C	D	E	F	G	H	2 hj	Rel. Est.
1. 30-sec. rod balance	498	056	037	042	079	−075	−020	−084	524	785
2. 30-sec. rod balance, replacement	729	011	−012	−040	−056	054	040	−100	794	817
3. 2 rod balance	513	−068	−025	−009	077	021	−008	012	508	857
4. Dynamic balance	201	004	141	−012	133	367	437	080	557	921
5. Static balance	193	070	−033	230	−049	324	006	044	342	665
6. Tempo-long-short	−046	460	023	033	072	−045	−005	−063	231	335
7. Tempo-arm exercise	081	519	070	−064	−016	−071	−041	095	310	626
8. Tempo-total body	−034	260	−045	158	−056	116	411	−061	271	357
9. Crosses and vertical lines	−002	068	488	−063	029	−076	008	054	321	773
10. Nose and ear	022	−085	452	063	−029	076	108	−054	345	787
11. Stick placing	−024	225	−015	451	054	085	000	016	403	903
12. Block tapping	024	−012	016	530	−054	−085	132	−018	381	807
13. Burpee	008	079	120	054	218	015	−005	068	174	716
14. Short potato race	−069	133	153	−089	519	−085	−026	−003	458	675
15. Soccer kicks	098	196	−038	168	339	013	166	017	465	833
16. Basketball throw	039	−028	156	015	524	−090	143	095	560	921
17. Ball catching	−053	133	−009	022	508	−031	131	469	678	756
18. Ball striking	057	000	−028	026	288	098	022	410	437	772
19. Johnson 3	−050	012	009	088	239	536	239	−082	586	822
20. Johnson 4	046	−059	−068	151	071	416	−087	035	380	753
21. Jump and reach	−081	−066	117	122	370	079	106	−034	347	934
Number of variables between ± .10	16	14	14	14	12	16	12	19		

[1]Decimal points have been omitted.

All variables appearing on Factor E have correlated with the "co-ordination" factor or factors identified in other studies, with the exception of the Johnson 4 item. Thus, this study verifies the selection of these items as having something in common. Other writers have called this factor "sensori-motor co-ordination," "gross body co-ordination," or "true motor educability." It should be recalled that previous factorial analysis of sports skills have identified strength and speed by tests which seemed to be simple enough to permit rather clear interpretation. However, after these factors were extracted from the matrix, some grouping of sport skills which did not have any test simple enough to permit clear identity appeared. To this factor the authors gave the name "co-ordination." It seems sensible to conceive of "co-ordination" as some combination of abilities which may be measured by rather simple tests rather than by complicated sports skills. It is for this reason that the present writer is dubious about calling this factor "motor co-ordination," as it has been identified in other studies.

One is prone to wonder if this factor is not more of a total body "quick change of direction" factor. Two of the variables appearing on this factor, the Burpee and the short potato race, are what physical educators have called "agility" measures. They involve a total body "quick change of direction." The present writer is hesitant to call this a quick change of direction factor because of the low correlation of the Burpee test with this factor. The choice of the Burpee as a quick change of direction item is probably a poor choice. The use of more tests such as the side-step, zig-zag, and dodging run might give more evidence that the type of ability involved on this factor is a quick change of direction. The "gross body co-ordination and agility" factor in the Larson study (15) had four quick change of direction items.

Factor F may be called *body balance*. One seems reasonably safe in identifying this factor as body balance, since these tests seem to be simple tests in that they are aimed at balance rather than at some such thing as motor educability. The latter is a more complicated concept. Bass (2) suggested that the dynamic balance test is measuring something besides the type balance in her study since the communality was low. She suggested that it might be some type of motor educability. Carpenter (3) suggested that the Johnson 3 and Johnson 4 items were on a factor which probably indicated "true motor educability." It would seem reasonable to believe that, if more Johnson items were analyzed in terms of more simple tests such as balance, tempo, and various type floor patterns, clearer identification of what has been called motor educability would be possible.

Factor G was extracted to facilitate rotation of Factor C, and to indicate some possible verifications that are needed. It will not be named in this study. After the extraction of the first six factors there were two doublets left in the residual matrix. One of the doublets included variables 4 and 8, dynamic balance and tempo (jump and arm pattern) respectively. It may be possible that this sort of factor is getting at an awareness of position in space and an

awareness of time-force relationships. Such an ability may be uncorrelated or independent of one's ability to perform at high speed, or to play baseball, or to strike an object. Rather, it may be a perception factor of where the body is in space, the amount of force, and when the force is applied to keep the body in that position.

Factor H was extracted because it was the only doublet left in the residual matrix and it was thought its extraction would help clarify the other factors. It will not be named. The two variables appearing high on this factor are the two which involved a ball that was thrown from a robot for the subject to catch or to strike. This would involve making judgments of the speed of the moving ball and of the space it would cover, and then adjusting the body to that moving object in order to perform the skill successfully. This factor, as well as Factor G, then, appears to be something of a perception factor.

Intercorrelation of Factors. Since this is an oblique solution, the factors are correlated. The intercorrelation of factors may be seen in Table 3, the $\emptyset$ matrix. Inspection of the 28 intercorrelations reveals that 11 are zero. This indicates that these factors are at right angles and hence, independent, of one another. Seven of the intercorrelations are near enough to zero to be thought of as independent of one another. Ten of the intercorrelations have large enough correlations to warrant consideration. Of these ten, seven are positively correlated, indicating an acute angle between the factors; three are negative, indicating an obtuse angle. It should be kept in mind that the correlations between these factors are subject to change should other samples of different age levels and different sexes be used. The reader may wish to examine Table 3 for a review of these intercorrelations. Comment will be made here only on the largest correlation in the $\emptyset$ matrix.

TABLE 3—Ø

Intercorrelation of Factors

Factor	A	B	C	D	E	F	G	H
A	1.000							
B	.057	1.000						
C	.114	.105	1.000					
D	.287	— .044	.383	1.000				
E	.569	.083	.083	.304	1.000			
F	.097	.176	.386	.193	.344	1.000		
G	— .030	— .045	— .422	— .216	— .141	— .266	1.000	
H	.079	— .022	.027	.251	— .130	.002	.141	1.000

The .569 correlation between Factor A (balancing objects) and Factor E seems logical since a number of sports skills in Factor E require adjustments in the use of hand and arm for successful performance. Factor A requires small quick adjustments with hand and arm to keep the rod balanced. These balancing-objects items have not been included in a factor analysis in physical education studies before. Evidence here, however, suggests that they be given serious consideration in the analysis of sports skills.

Results and Conclusions

Eight factors were obtained from this analysis, five of which were given names. Five of these factors seem to permit clear interpretation by rather simple tests. Therefore, the first hypothesis has to be accepted.

The factors underlying the 21 variables used in this study seem to permit the following names: *Balancing Objects, Tempo, Two-Handed Agility, Speed of Change of Direction of the Arms and Hands, Body Balance.* Therefore, the second hypothesis has to be accepted.

This study seems to permit the following conclusions:

1. Variables used in the past to measure motor co-ordination, motor proficiency, or sports skills do group themselves around certain abilities.
2. While variables do group around certain abilities, there is an indication in this study that further factors, which have not been considered in studies of this kind, are pertinent to motor co-ordination. Factors G and H in this study indicate such a conclusion.
3. Factor E confirms the selection of "co-ordination" variables from several factorial studies as having something in common. The author, however, questions naming this factor motor "co-ordination."
4. Factor A (balancing objects) warrants consideration in the analysis of sports skills because of the .57 correlation of this factor with Factor E.
5. The two motor educability items used in this analysis are best identified in terms of total body balance.
6. The appearance of the block-placing-for-speed and the kick-for-distance items on the tempo factor indicates that these variables require some degree of the ability to time movements of the body. However, the tempo items used in this study were a narrow interpretation of timing movements. No "timing" in relation to outside objects was considered in the tempo tests. Moreover, the tempo items were not very reliable and need further refinement.
7. The intercorrelation of factors indicates no relationship between the two-handed agility factor and Factor E. None of the sports skills appeared on the former factor. This could be due to an absence of similar movement patterns in the sports skills and the novel, trick-type tests by which Factor C was identified. In addition, the novel tests in Factor C seem to require some degree of concentration or ability to grasp what is expected in order that they may may be executed properly. The two Johnson items also seem similar in this respect. There is some indication of relationship between this Factor C (two-handed agility) and Factor F on which the two Johnson items appear.
8. No final definition of motor co-ordination can be given in terms of abilities from this study. Further clarification of Factors G and H seems needed, as well as more clarification of Factor E, which is primarily composed of sports skills.
9. The multiple-group method of factoring these motor co-ordination variables gave a more decisive reduction of the intercorrelation matrix than did the centroid method.

PART II

Comparison of the Centroid and the Multiple-Group Methods of Factoring

The last conclusion in Part I suggests a possible discrepancy in factors obtained when different methods of factoring are used. In an effort to determine the number of factors present in the intercorrelation matrix, the solution of this problem was begun by extracting three centroids. Test-retest reliability estimates were used as communality estimates so that only reliable variance would be extracted from the intercorrelation matrix. After the extraction of three centroids, vectors were extended (25) and plots made. Since the variables seemed to cluster fairly well on the plots, the centroid approach was continued.

The question of when to stop factoring in factor analysis is an important one. Essentially, one attempts to reduce the intercorrelation matrix to zero. Two criteria were applied to determine when the factoring should be stopped. Thurstone (27) reported an empirical rule developed by Tucker. This rule is based on the idea that only chance variance will remain in the residuals when the significant factors have been taken out. Such a criterion is of course appropriate when factors are extracted one at a time as in the centroid method. Coombs (5) has given another criterion which is based on the idea that the number of negative signs (after sign change) expected in the residual matrix is a function of the number of variables. From his graph, a table was made from which one could determine directly the total number of negative signs to expect from a certain number of tests when the factoring was adequate.

Applying Tucker's and Coombs' criteria for when to stop factoring, the following resulted:

		Coombs	Tucker
Factors extracted	Critical values	160±10	.952
9			.964
8		160	.918
7		144	.971
6		170	.941
5		140	.945
4		148	.946
3		153	.980
2		171	.944

As can be seen, there is no consistency between the criteria applied. The negative signs should increase after each factor in Coombs' criterion, and the ratio in Tucker's criterion should increase. This was not the case. Rather, there was a constant fluctuation both within each criterion and between the two criteria. For example, after two factors had been extracted, Coombs' cri-

terion suggested enough factors had been extracted, while the Tucker criterion suggested the factoring be continued. After six factors had been extracted, Coombs' criterion once more suggested that the factoring should be stopped, but the Tucker criterion suggested factoring should be continued. (The Tucker criterion had suggested the factoring was adequate after three factors had been extracted.) Then, after seven factors had been extracted, the Coombs criterion suggested a continuation, while the Tucker criterion suggested the factoring was adequate.

Although the criteria did not answer with complete satisfaction the question of when to stop factoring by this centroid method, it was decided to try to rotate five of the obtained factors to see if there was some interpretation possible. C. W. Harris (9) has given a method of direct rotation. This is done by looking at the plots of extended vectors to determine the points at which the planes intersect. The direction numbers of these points are taken as the basis for the transformation matrix of direction cosines. After the direct rotation was made, several adjustments were made by radial and by single plane rotations to try to put the variables in a hyperplane which permitted interpretation.

As indicated in Part I, dissatisfaction with the rotations, and with the appearance of the residual matrix after the extraction of nine factors resulted in changing to the multiple-group method of factoring. This change was made to see if clearer identifications and a cleaner reduction of the intercorrelation matrix was possible. As may be seen by the residual matrix, Table 4, several doublets were left in the residual matrix after the extraction of nine factors by this centroid method.

Purpose

It is the purpose of this section to compare the centroid and the multiple-group methods of factoring the same empirical data.

Procedure

Since the calculated communalities using the multiple-group method were smaller than the reliability estimates used in the first solution by the centroid method, the intercorrelation matrix once again was factored by the centroid method, using the same communalities as was used in the multiple-group method. Only six centroids were extracted, since the multiple-group method gave six factors which were interpreted.[5]

One method of comparing the centroid solution with the multiple group solution is to make a least squares approximation of one solution to the other. This is a well-established statistical procedure and has recently been reviewed by C. W. Harris (11). In this instance a least squares approximation to the F matrix was made from the V matrix since "V" was of greater rank than

[5]It was suggested in Part I that Factors G and H were extracted to aid in rotation, to remove the two remaining doublets from the residuals, and to possibly indicate further clarifications needed.

TABLE 4

Centroid Residuals After Extraction of Nine Factors[1]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1																					
2	-014																				
3	107	005																			
4	-070	000	-005																		
5	002	012	-052	-058																	
6	-040	053	-007	050	047																
7	-029	-046	013	019	-012	-010															
8	013	040	011	-041	062	-013	-055														
9	-080	-036	-023	016	-081	001	-002	-053													
10	-002	-013	-003	-098	-012	004	-022	022	141												
11	-049	029	-082	-002	028	036	-048	-049	028	-038											
12	029	-016	-003	-033	-132	-088	-037	-049	-003	-062	107										
13	-030	-054	042	064	-040	-063	074	-019	068	-063	-021	020									
14	023	-010	-048	014	-002	009	-040	-043	005	044	022	002	-104								
15	-024	048	-056	-049	005	-034	008	064	-036	019	-019	-017	-016	-006							
16	019	-003	-028	-020	008	021	-024	003	-088	-070	-025	-016	-071	-028	-019						
17	023	012	-005	-046	034	-014	-014	-019	033	037	-018	-064	017	033	035	-008					
18	-010	-028	-023	022	-014	-003	027	012	-003	009	014	023	-004	-002	032	-016	-074				
19	-013	-022	-013	-095	015	-047	033	002	-001	025	-004	052	005	-024	-009	-027	-016	-022			
20	018	-027	044	067	047	-005	009	-006	-066	-096	-012	013	047	-005	-116	-036	-040	-042	042		
21	-024	-023	-045	038	-077	-004	018	-012	-056	-036	-083	-001	-073	014	008	179	-040	003	001	-025	
	001	-001	001	000	001	001	000	001	-001	-001	000	001	-001	-001	-001	-001	001	-001	001	-001	000

[1]Decimal points have been omitted.

TABLE 5

Residuals After Extraction of Six Centroids[1]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	024																				
2	002	-029																			
3	-027	060	-033																		
4	002	-034	020	028																	
5	021	025	-002	-004	012																
6	033	-019	026	023	-074	-020															
7	-012	008	-008	-068	026	033	014														
8	000	026	-041	046	081	-037	-021	015													
9	044	-018	003	-052	003	057	-073	-013	024												
10	018	-016	023	-037	-015	012	024	-054	041	047											
11	-025	020	002	050	012	004	-017	-028	-020	-058	011										
12	-037	011	-008	-017	-011	053	073	-060	-037	049	040	047									
13	020	-006	-028	007	-015	-061	016	036	-022	-023	-019	021	016								
14	009	-050	-010	027	005	-022	-029	-003	-069	-016	-038	016	055	071							
15	002	-038	-003	022	-046	-018	006	006	062	-031	-008	-027	047	000	026						
16	013	036	011	-019	-001	-013	053	-011	080	-009	017	012	-063	032	-069	014					
17	012	-019	021	-038	-036	-007	-017	026	064	-005	-028	-008	004	-041	024	-017	061				
18	029	-023	-018	004	037	-008	-060	-013	032	003	-043	-108	021	-006	049	-038	051	083			
19	-025	022	005	-039	-029	-013	053	007	-014	060	007	023	-035	000	-004	001	001	045	047		
20	-040	-002	016	052	014	-009	-034	060	-070	-022	052	-043	015	033	018	-022	-027	023	-061	066	
21	-063	044	-009	028	-004	060	033	-023	-022	011	071	010	013	036	-021	-007	-022	-060	-051	-019	-006
	000	000	000	001	-001	000	000	-001	000	002	002	-001	-001	000	-003	000	-001	000	000	000	-001

[1]Decimal points have been omitted.

"F." The idempotent matrix "X" was computed from "V" and "F," [$X = (V^1V)^{-1} V^1 F$]. "V" was multiplied by X to give the matrix F_1, the least squares approximation to the centroid solution, ($VX = F_1$). F_1 was subtracted from F to show differences in the two solutions.

Discussion of Data

Table 5 records residuals after the extraction of 6 centroids, using the same communalities as was used in the multiple-group method. Table 6 is the F matrix of the centroid solution; Table 7 the least squares approximation matrix, F_1; Table 8 contains the difference between the F and the F_1 matrices. A comparison of Table 6 and Table 7 indicates that the two solutions are quite similar. Further, inspection of Table 8 indicates that for all practical purposes the two solutions are comparable since the majority of the entries are essentially zero.

In all probability, the use of the reliability estimates so that only reliable data would be factored was a poor communality estimate for the first centroid solution. These reliability estimates are higher than the calculated communalities, as may be seen by comparison of the h_j^2 and the reliability estimates in Table 2, Part 1.

TABLE 6

Centroid Factor Matrix—F[1]

	1	2	3	4	5	6	h_j^2
1	5398	−3199	3119	1376	−0688	0997	5246
2	6012	−3684	3731	2181	2229	−1792	7657
3	5160	−3523	2520	1897	0869	−0890	5053
4	6001	0785	−1878	2547	2069	−1473	5309
5	4897	1726	0799	1013	1991	0147	3261
6	1885	2109	0888	−2948	−2079	−1933	2554
7	1856	1412	1427	−2533	−0519	−3148	2407
8	1117	1825	−1103	−2058	1619	−3516	2501
9	2133	2748	2175	0509	−3335	1163	2957
10	2353	3114	1209	2117	−1813	2271	2962
11	4682	2391	0769	−1678	0975	2128	3652
12	2599	1189	1924	−1924	2379	3093	3080
13	3926	0244	−0127	−0155	−1491	0811	1839
14	5254	−1390	−1778	−0468	−3485	0466	4528
15	6194	−1842	−0426	−1584	0328	−0593	4491
16	6433	−3218	−1219	−0392	−0919	0619	5461
17	6340	−2457	−2477	−2480	0928	0446	5958
18	5170	−1501	−1190	−0849	2216	2118	4052
19	4809	1752	−4489	3092	0072	−0864	5666
20	4425	1854	−1584	2020	0447	1115	3105
21	4950	−0329	−2234	0331	−1482	1102	3312

[1]Decimal points have been omitted.

TABLE 7

Least Squares Approximation Matrix—F_1[1]

	1	2	3	4	5	6	$\sum_j h_j^2$
1	539	−325	326	112	−028	−033	5168
2	613	−371	393	222	226	−129	7849
3	519	−367	233	201	092	−023	5077
4	571	051	−194	237	179	−205	4965
5	473	180	047	127	170	065	3076
6	181	173	049	−259	−175	−148	1847
7	199	168	183	−271	−109	−241	2447
8	098	177	−108	−176	204	−303	2170
9	214	277	195	063	−296	156	2765
10	243	321	131	212	−193	202	3022
11	467	245	090	−206	088	198	3756
12	279	106	204	−194	220	299	3061
13	390	011	−017	−024	−108	097	1742
14	515	−167	−161	−054	−365	034	4563
15	617	−175	−077	−143	018	−057	4413
16	644	−294	−137	−024	−142	065	5449
17	643	−243	−232	−267	145	063	6226
18	517	−154	−130	−064	200	121	3666
19	539	208	−425	271	110	−097	5974
20	413	165	−159	234	076	138	3027
21	477	−044	−201	060	−135	155	3157

[1]Decimal points have been omitted.

TABLE 8

Differences Between F and F_1[1]

	1	2	3	4	5	6	$\sum_j h_j^2$
1	001	−005	−014	026	041	133	0078
2	−012	−003	−020	−004	−003	050	−0192
3	−003	−015	019	−011	−005	066	−0024
4	029	028	−006	018	028	−058	0344
5	017	−007	033	−026	029	−050	0185
6	008	038	040	036	033	045	0707
7	−013	−027	−040	−018	−057	074	−0040
8	014	005	002	030	−042	049	0331
9	−001	−002	023	−012	038	−040	0192
10	−008	−010	−010	000	−012	025	−0060
11	001	−006	−013	−038	010	015	−0104
12	−019	013	−012	−002	018	010	0019
13	003	013	−004	−009	041	−016	0097
14	010	−028	017	−007	−016	012	−0035
15	002	009	−034	015	015	002	0078
16	−001	028	−015	015	−050	−003	0012
17	−009	003	016	−019	−052	−018	−0268
18	000	−004	−011	020	022	091	0386
19	−058	−033	024	038	−003	−011	0308
20	029	020	−011	−032	−031	−026	0078
21	018	−011	022	−027	013	−045	0155

[1]Decimal points have been omitted.

Summary and Conclusions

This section of the paper has been devoted to comparing the centroid and the multiple-group methods of factoring. A leastsquares approximation of the F matrix from the V matrix was made. It was shown that, for all practical purposes, the two methods yield similar solutions when the same communalities are used in both solutions.

The author is inclined to think there is merit in the use of the multiple-group method of factoring, however. The centroid method is a laborious method which requires the reproduction of the matrix after the extraction of each factor, while the multiple-group method requires a reproduced matrix after the extraction of several factors. Residuals after the extraction of one factor at a time often leave one in doubt about remaining facotrs. The simultaneous extraction of several group factors leaves residuals which, in many instances, indicate rather clearly the remaining groups.

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(Submitted 1-17-54)

Inventory To Determine Attitudes of College Women Toward Physical Education and Student Services of the Physical Education Department

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Abstract

This article presents a statistical analysis of an attitude inventory composed of statements regarding physical education and the services offered students by a physical education department. The analysis covers reliability and validity of the 20 attitude statements included in order to measure attitude toward physical education. The statements were found to be reliable and valid. Correlation coefficients of parts of the Inventory other than the attitude statements show significant relationships valuable to teachers and administrators. A copy of the inventory appears at the end of the article.

AN ATTITUDE INVENTORY, composed of statements regarding physical education and the services offered students by a physical education department, was used to determine the students' attitudes. A form of the original inventory was given to 90 Freshmen and Sophomore women enrolled in the physical education required or service classes at the University of Oklahoma. As a result of analysis of responses from this preliminary try-out, several items were dropped, because by inspection they were ambiguous or failed to discriminate, other were revised, and a few new ones were added.

The Inventory

Part I of the revised list contained 31 activities about which the individual responded "I enjoy this activity," "I would like instruction in this activity," and "My estimate of my skill in this activity." Part II consisted of a series of 54 statements of which 20 were statements to measure the attitude toward physical education. The remaining 34 statements were included in order to determine the students' attitudes toward facilities, equipment, instruction, gymnasium costume, organization, and administration. The final statement within Part II was an estimate of the individual's present skill in physical education activities in general.

The personal data of the inventory included the individual's college classification, name, and grades in Junior High School, Senior High School, and College in which the individual participated in a voluntary and/or required physical education program.

The Attitude Inventory was given to 739 women enrolled in the physical education required or service classes at Baylor University, Waco, Texas. Since it was necessary to secure the teachers' ratings of the students' attitudes as revealed by behavior in class, it was deemed advisable to conduct the study in the latter half of the fall quarter. The inventory was administered in the middle of November 1952.

Evaluation of the Inventory

A series of 20 attitude statements were randomly placed throughout the inventory. The Likert technique of arbitrarily weighting and summating was followed in this portion of the inventory. The reliabilities of these 20 attitude statements were determined by the split-half (corrected by Brown-Spearman formula) and retest techniques. They are: split-half corrected, $r=.94\pm.030$; retest, $r=.90\pm.020$. Product-moment correlation coefficients were computed to express the relationship between each attitude statement and the total attitude score made on the statements. All of these are statistically significant in terms of their probable errors, with the lowest correlation still being over 11 times greater than its probable error. Using the statistical significance as a criterion, each statement was retained as valid in the final form of the inventory.

The validity of the attitude statements was determined in several ways. The high reliability on the retests comes from individual honesty of response and may be used as an index of validity. The correlation of the teachers' ratings with the total score showed a statistically significant, but low, correlation ($r=.26$). This was probably due to the fact that the teachers had not been with the students the necessary length of time to judge adequately their attitudes as expressed by behavior in class.

The obtained and theoretical frequencies with the standard deviations were determined in order to calculate the normalcy of the distribution by the Dickey G method. The range is from -3.88 SD to $+2.58$ SD, which for 739 cases is wide. This is an index of validity as it shows a range as large or larger than one would expect. The 91 per cent normal, computed by the Dickey G method, shows a natural expectancy as to distribution, although a little skewed to high scores. This computation by the Dickey G method is a high index of validity, or an index of discrimination. It should be noted, however, that the mean score, around which the normalcy of the curve resulted, is 74, which is 14 points above the "undecided" mean of possible scores, in as much as the possible range of scores was from 20 (strongly negative) to 100 (strongly positive).

Although there has been much criticism about the use of attitude tests without their validity having been established, this study has attempted to use an outside criterion (teachers' ratings) as well as other means for determining validity. L. L. Thurstone, an authority in the field of attitude measurement, believes that it is of interest to know what people say they believe even if their conduct turns out to be inconsistent with their professed opinion (32, *p. 9*).

Correlation coefficients of parts of the Inventory other than the attitude statements show significant relationships valuable to the teacher. The correlation coefficients of parts of the inventory other than the attitude statements are given in Table 1.

TABLE 1
Correlation Coefficients of Parts of the Inventory

Items	Correlation
Column A with Column B	.71 ± .012
Column A with Column C	.82 ± .008
Column B with Column C	.54 ± .017
Column A with Total Score	.09 ± .025
Column B with Total Score	.41 ± .020
Column C with Total Score	.25 ± .023
Teachers' Rating with Total Score	.26 ± .023
Statement 55 with Column C	.50 ± .018

Column A ("I enjoy this activity") had a fairly high correlation (r=.71) with Column B ("I would like instruction in this activity"). There is a greater relationship (r=.82), however, between Column A ("I enjoy this activity") and Column C ("My estimate of my skill in this activity"). There is a lesser degree of relationship (r=.54) between Columns B ("I would like instruction in this activity") and C ("My estimate of my skill in this activity").

There is a very low relationship between Column A ("I enjoy this activity") and a student's total score on the attitude statements (r=.09).

Column B, which was a totaled response to statements regarding desire for instruction in specific activities, has a low, but significant,[1] relationship to attitude toward physical education as revealed by the total score (r=.41).

There is also a low correlation coefficient between total skill in specific activities and attitudes which is revealed in the correlation between Column C ("My estimate of my skill in this activity") and the total score (r=.25). These last two correlations are statistically significant.

The relationship of statement 55, which was a student's rating of her present skill in physical education activities in general, with Column C, which was a totaled rating of her skill in specific activities, shows fair and positive reliability (r=.50).

The statements in the inventory which were concerned with facilities, equipment, personnel, instruction, organization, program content, and administration were summated and percentages were computed for each of the responses.

To clarify the method used to summarize these responses a sample of the total table is shown in Table 2.

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[1]"Significant" hereafter denotes "statistical significance", which means the correlation is positive and is at least four times greater than its probable error.

TABLE 2

Percentages of Responses for Six Selected Inventory Items Other Than the Attitude Statements and Total as an Agreement Index

Statement	Strongly Agree (+2)	Agree (+1)	Undecided (0)	Disagree (—1)	Strongly Disagree (—2)	Extent of Agreement Index
11	13.66	46.01	15.83	21.65	2.71	46.26
12	10.28	22.46	13.39	45.60	8.25	—19.08
13	1.08	8.80	21.65	55.07	13.39	—70.89
14	1.62	7.17	23.95	60.21	7.04	—63.88
15	1.62	7.71	21.51	57.91	11.23	—69.42
16	8.80	66.57	17.18	6.77	.68	76.04

The six selected statements were concerned with physical education uniforms, and read as follows:

Statement 11. "The uniform for each type of physical education class should be the same for all women students."

Statement 12. "Women should be allowed to wear any appropriate and comfortable play clothes for physical education classess."

Statement 13. "The physical education department should rent uniforms to the women enrolled in the physical education classes."

Statement 14. "I think our physical education costumes are too expensive."

Statement 15. "The physical education department should furnish uniforms to the women's classes."

Statement 16. "Women should buy their own physical education costumes."

In order to determine an "Extent of Agreement Index," the responses of Strongly Agree, Agree, Disagree, and Strongly Disagree were arbitrarily weighted +2, +1, —1, —2, respectively. The percentages of each of these responses were multiplied by the respective weights, and added algebraically. This "Extent of Agreement Index" shows the total positive or negative weight of each response.

Recommendations

Although the primary purpose of this study was to construct an attitude inventory, examination of the data obtained suggests certain hypotheses which should be subjected to further study.

The high degree of correlation between enjoyment of specific activities and estimated skill in such activities (r=.82) suggests that if "carry-over" attitudes toward activity are to be achieved, opportunities to develop satisfying skills will be helpful. Although this is seemingly logical, it is not always apparent to teachers. The inventory thus may be used as a curricular guide. The lesser, but significant, degree of relationship between estimated skill in specific activities and desire for instruction (r=.54) may indicate that estimated skill is less a determining factor than general attitude toward physical education with regard to desire for instruction. By using the attitude inventory, administrators and teachers may become aware of students' existing attitudes, and the desirability of attempting to modify these attitudes where they are not indicative of readiness to learn.

The lack of relationship between enjoyment of specific activities and general attitude toward physical education (r=.09) suggests that educators may encourage the development of desirable attitudes toward physical education in general, even in courses not specifically preferred by the students.

The low, but significant, relationship between desire for instruction in specific activities and general attitude toward physical education (r=.41) may be used as a starting point for developing attitudes through suitable instruction.

Educators could make use of the statistically significant relationship between estimated skill in specific activities and general attitude toward physical education (r=.25) by promoting the development of skills in specific activities as a means of encouraging desirable attitudes toward physical education in general.

Cognizance of the positive relationship between estimated skill in specific activities and estimated skill in physical education activities in general (r = .50) may be used to advantage by instructors in developing general physical education programs.

The inventory is in such a form that, by rearranging, it could easily be administered in two parts, if desired. The 20 attitude statements could be administered solely for the purpose of measuring attitudes toward physical education. The statements regarding the specific activities, facilities and equipment, instruction, costume, personal statements regarding showers, organization, and administration might be given, apart from the attitude statements, to survey attitudes in these areas.

Summary

1. A valid and reliable twenty-item inventory of attitude toward physical education has been developed.

2. A tool is offered for surveying student attitude toward organizational and administrative services offered by college women's physical education departments.

A copy of the attitude inventory is found on page 435.

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APPENDIX

AN ATTITUDE INVENTORY

An Instrument to Measure the Attitudes of College Women Toward the Physical Education Program

UNDERLINE ONE: FR. SOPH. JR. SR. DATE _____

CHECK IN THE PROPER COLUMN THE GRADES IN WHICH YOU PARTICIPATED IN AN ORGANIZED PHYSICAL EDUCATION PROGRAM _____

GRADE	VOLUNTARY	REQUIRED
7th		
8th		
9th		
10th		
11th		
12th		
College Fr.		
College Soph.		
College Jr.		
College Sr.		

In an effort to improve the Physical Education program at this university this Inventory has been constructed to determine your attitudes toward Physical Education. Your name is needed only in order to match this Inventory with later results. Your answers will in no way affect your grade or the attitude of the instructor toward you. Please be honest in your responses, and answer *every* item.

READ *ALL* STATEMENTS CAREFULLY AND INDICATE YOUR FIRST REACTION. WORK QUICKLY AND INDICATE THE WAY YOU HONESTLY FEEL ABOUT THE STATEMENT.

Name _____

PART I

You are being given three statements with regard to each of a number of activities often included in physical education programs. Following the key given in each column, record the *NUMBER* corresponding to your attitude toward that activity with respect to the statement given. Take each row across the page in responding to the statements regarding the various activities.

ACTIVITY	A I enjoy this activity Key: 5 Strongly agree 4 Agree 3 Undecided 2 Disagree 1 Strongly disagree 0 Have no experience on which to judge	B I would like instruction in this activity (regardless of whether or not you have had previous instruction) Key: 5 Strongly agree 4 Agree 3 Undecided 2 Disagree 1 Strongly disagree 0 Have no experience on which to judge	C My estimate of my skill in this acitvity is: Key: 5 Excellent 4 Good 3 Fair 2 Poor 1 Extremely poor 0 Have never tried it
1. Archery			
2. Badminton			
3. Basketball			
4. Billiards			
5. Bowling			
6. Canoeing			
7. Conditioning Ex.			
8. Deck Tennis			
9. Fencing			
10. Fieldball			
11. Folk Dancing			
12. Golf			
13. Handicrafts			
14. Hockey			
15. Horseback Riding			
16. Horseshoes			
17. Modern Dancing			
18. Paddle Handball			
19. Posture Improvement			
20. Shuffleboard			
21. Soccer			
22. Social Dancing			
23. Softball			
24. Speedball			

ACTIVITY	A	B	C
25. Square Dancing			
26. Swimming			
27. Table Tennis (Ping Pong)			
28. Tap Dancing			
29. Tennis			
30. Tumbling			
31. Volleyball			

PART II

Please read each statement carefully and underline your reaction to it *at once.* Be sure to answer *every* item.

1.* Activities learned in physical education classes have little value outside of class.
STRONGLY AGREE AGREE UNDECIDED DISAGREE STRONGLY DISAGREE[1]

2. The voluntary intramural program should include those activities learned in physical education classes.
3. I like team sports such as Basketball and Volleyball better than individual sports such as Archery and Tennis.
4. Individual sports are more useful to me than team sports.
5.* Physical education facilities and equipment should be available to students for recreational use outside of class hours.
6. The physical education department should furnish soap and towels to all students in physical education classes.
7. I like lockers better than baskets.
8. The physical education department should furnish all equipment for golf classes.
9. The physical education department should furnish all equipment for tennis classes.
10. The physical education department should furnish all equipment for badminton classes.
11. The uniform for each type of physical education class should be the same for all women students.
12. Women should be allowed to wear any appropriate and comfortable play clothes for physical education classes.
13. The physical education department should rent uniforms to the women enrolled in the physical education classes.
14. I think our physical education costumes are too expensive.
15. The physical education department should furnish uniforms to the women's classes.
16. Women should buy their own physical education costumes.
17. One large shower room with several fixtures is better than individual shower stalls.
18. I enjoy taking a shower after physical education class.
19. Showers should be required after physical education class.
20. I like to take my shower and dress in private.
21. I would take a shower after physical education class if we had hair dryers.
22. I would be more inclined to take a shower more frequently after physical education class if I had more time for dressing.

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*One of the 20 statements to measure attitude toward physical education.
[1]Each statement carried these five reactions in the original inventory. Because of space, they are omitted here in statements 2-54.

23.* Participating in physical education activities improves my health.
24.* Physical education classes are dull.
25.* Participating in physical education activities helps teach people to get along better with one another.
26.* Participating in physical education activities is fun.
27.* Physical education classes are helpful in making friends.
28.* Physical education teaches skills useful in adult recreation.
29.* Physical education should be required for all four years of college.
30.* Physical education encourages habits of safety.
31.* Physical education is of little value.
32.* Participating in physical education activities is refreshing.
33.* Physical education encourages skills and attitudes useful in later family living.
34. Regular credit should be given for physical education.
35.* Physical education classes are a waste of time.
36.* Women should be encouraged to take courses in the physical education activities in which they are poorly skilled.
37.* College women get enough exercise without taking physical education.
38. Physical education should not be required of Freshmen and Sophomore college women.
39. The time given for dressing and showers is adequate.
40.* Physical education classes should meet every day.
41. Physical education should be elective for those who like it.
42.* I would like to get instruction in additional physical education activities in my junior and senior years.
43.* I take physical education only because it is required.
44. Every woman student should be allowed to take whatever physical education class activity she desires.
45. My instructor makes the class enjoyable for me.
46. Participating enthusiastically should be the main basis for grading physical education.
47. Regular grades, A. B. C., etc., should be given in physical education.
48. My instructor makes the class profitable for me.
49. Improvement in skills should be the main basis for grading physical education.
50. My instructor does not instruct, she just lets us play.
51. Written tests help instructors evaluate what students are accomplishing in physical education classes.
52. Regularity of attendance should be considered in grading physical education.
53. My instructor talks too much, and does not let us play enough.
54.* It is important to learn the rules of the various games while learning the skills.
55. My estimate of my present skill in physical education activities in general is: (Check one) Excellent ( ); Good ( ); Fair ( ); Poor ( ); Very Poor ( ).

(Sumbitted 1-12-54)

Measuring Selected Motor Skills in Fourth, Fifth, and Sixth Grades

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Abstract

This article presents seven tests which were devised for measuring selected motor skills in fourth, fifth, and sixth grade boys and girls. An analysis of the data indicated that the tests were reliable for the population measured, and that age, height, and weight factors were not statistically significant in determining performance as measured by these tests. Performance standards were computed for each sex within each grade level.

THE PURPOSE OF this study was (1) to design some satisfactory measure of achievement in selected motor skills for boys and girls in grades four, five, and six, (2) to establish norms of standards of performance in these skills for the population measured, and (3) to determine the relationship, if any, of such factors as age, height, and weight to performance as measured by the given tests.[1]

Method of Procedure

An examination of the physical education activities at the fourth, fifth, and sixth grade levels indicated that the fundamental skills of running, jumping, throwing and catching, striking, and kicking are basic to performance in many of these activities. Previous studies on motor performance at the elementary school level have indicated that increments in age, height, and weight are generally assumed to increase proficiency in performing activities (2, 3). These three factors have appeared to exert more influence on the boys scores than on the girls scores. In a recent study with primary grade children little or no reltationship between gross motor skill performance and age, height and weight was indicated (5).

A number of established tests which measure performance in running, jumping, throwing and catching, striking, and kicking at the high school and college levels were investigated, and the following general procedure was used in determining the necessary revisions in selecting those tests most suitable for the abilities of the subjects:

1. The selected test was given in its original form to a group of 67 boys and girls in the fourth, fifth, and sixth grades.
2. The children were observed carefully during performance, and after inspecting the scores, revisions in size of target, distance from target, time allotment, number of trials, and other necessary changes were made.

[1] This study was made in partial fulfillment of the requirements for a Doctor's degree at the University of Iowa, August 1952.

3. The revised test was administered to the same subjects.

4. If further revisions were necessary, the same procedure was followed, until the test appeared to be a satisfactory measure of the performance of this pre-test group.

Seven tests which were adaptations from established tests reported in Scott and French (4) were finally selected.

The jumping tests consisted of the Standing Broad Jump for distance and the Vertical Jump for height. Two throwing tests were selected, the Basketball Wall Pass and the Softball Repeated Throws, in an effort to measure the child's ability to manipulate these two types of balls. In the kicking area, the Soccer Wall Volley was established. The Volleyball Wall Volley was used to measure striking ability and the Shuttle Run to measure agility and speed in running. The descriptions of these tests follow:

BASKETBALL WALL PASS

This test measures the ability of the subject to throw a basketball successively into a given target area from a specified distance.

Equipment.

1. Regulation basketball, stop watch.
2. Markings: On a flat wall space, mark a target area 8 ft. wide and 4 ft. high, at a distance of 3 ft. from the floor. A restraining line 8 ft. long is drawn on the floor 4 ft. from the wall and parallel to the wall target.

Test. The subject stands at any place he chooses in back of the restraining line. On the signal "Go" he throws the ball against the wall into the traget area in any manner that he chooses, and continues successive throws until the signal "Stop" is given. If the ball gets out of control at any time, he must recover it himself without assistance. A successful throw is one that goes into the target area and is made from behind the restraining line. Line balls are not fair hits. The ball may be caught on a bounce if the subject so chooses. However, the ball need not be caught to constitute a successful throw.

Scoring. One point is given for each successful throw. The subject is given a ten second practice trial. The test administrator scores verbally during this trial, encourages the subject to retrieve lost balls rapidly, and to throw the ball as fast as he can successfully manipulate it. This score is not recorded.

Two 15-sec. trials are given, after the practice trial. The total number of points is recorded for *each* trial. The better of the two trials is the final score for the test.

VOLLEYBALL WALL VOLLEY

This test measures the ability of the subject to strike a volleyball with the hands a repeated number of times against the wall within a given target area and from a specified distance on the floor.

Equipment.

1. Regulation volleyball, stop watch.
2. Markings: On a flat wall space, mark a target area 8 ft. wide and at least 4 ft. high, at a distance of 3 ft. from the floor. A restraining line 8 ft. long is drawn on the floor 4 ft. from the wall and parallel to the wall target.

Test. The subject stands at any position he chooses in back of the restraining line. On the signal "Go" he tosses or throws the ball against the wall into the target area, and as it rebounds he continues to bat it repeatedly against the wall. The ball may be tossed against the wall when it is necessary to start it again. If the ball gets out of control, the subject retrieves it himself, brings it back to the restraining line, and starts it again. A successful hit is one that, upon rebounding from the wall, is clearly *batted* into the target

area from behind the restraining line on the floor. If the ball is thrown or pushed against the wall, it does not constitute a successful hit. Line balls are not fair hits.

Scoring. One point is given for each successful hit. The subject is given a ten second practice trial. The test administrator scores verbally during this trial, calling the attention of the subject to balls that are not legal hits if he pushes the ball at any time. This score is not recorded.

Four 15-sec. trials are given, after the practice trial. The total number of points is recorded for *each* trial. The best of the four trials is the final score for the test.

VERTICAL JUMP

This test measures the ability of the subject to jump vertically and reach as high as possible from a stationary position on the floor.

Equipment. One-in. cloth strips suspended from a horizontal bar, and spaced at 1-in. intervals from each other. The longest strip is 5 ft. from the floor and the shortest strip is 8 ft. 11 in. from the floor. Each strip is weighted with a penny at the end nearest the floor to insure even hanging.

Test. The subject stands with both heels on the floor under the suspended strips, and reaching with one hand, touches the highest strip that he can. This is recorded under "reaching height." The subject jumps from a stationary position under the bar, and reaches the highest strip that he can. He may start from a crouch if he wishes, but he may not take any steps or preliminary bounces. Any number of trials is allowed, but it is advisable to estimate the approximate place along the scale where the subject's best jump will be, in order to avoid fatigue from too many trials.

Scoring. The score is the difference in inches between the height of the reach and the height of the best jump.

STANDING BROAD JUMP

This test measures the ability of the subject to jump horizontally from a standing position.

Equipment.

1. Tumbling mat, at least 9 ft. long.
2. Measuring tape, unless mat is calibrated permanently.

Test. The subject stands with both toes touching the restraining line that marks the take-off area, and from this standing position jumps as far forward as he can. Any preliminary movement that is made must be executed with some part of both feet in contact with the take-off area. The subject is given three successive trials and measurement is taken to the last inch. For example, if the subject jumps 5 ft. 2½ in., the jump is recorded as five feet-two inches. This distance is measured from the restraining line of the take-off area to the nearest contact made on landing. (This is usually to the first heel mark made on landing, but if the subject loses balance, falls backward and catches himself with his hand or body, the mark nearest the restraining line is used in measuring the distance of the jump.)

Scoring. The best of three trials, in feet and inches, is the score for the test.

SHUTTLE RUN

This test measures the ability of the subject to run rapidly between two given marks, necessitating quick stops and changes of direction.

Equipment.

1. Stop watch, calibrated in 1/10 sec.
2. Markings: Two 12-in. lines are marked on the floor, parallel to each other and at a distance of 20 ft. apart. The line that is indicated to be the starting line should have an area in back of it free from obstruction that is at least 20 ft. long, to give the runner an opportunity to check his speed *after* passing this line upon completing his run.

Test. The subject stands with the toe of his forward foot on the starting line. On the signal "Go" he runs to the opposite line, touches it (or beyond it) with one or both feet. This constitutes one complete trip. The subject does not stop, but continues running to the opposite line until he has completed three trips, or a total of 120 ft. If the subject fails to touch, or step over, a line at any time during the run, he is stopped at once and no score is recorded for the trial. After a brief resting period he is given one opportunity to repeat this performance, and if he fails again to execute the test correctly, the test score is rejected.

The time in 1/10 sec. is taken from the signal "Go" to the crossing of the starting line upon completing the three trips (120 ft.).

Two trials are given in this test. Subjects are tested in pairs, with one of the pair resting while the other is performing, thus alternating with each other on the trials.

Scoring. The score for this test is the better of the two trials, recorded in seconds to the nearest tenth.

SOCCER WALL VOLLEY.

This test measures the ability of the subject to kick a soccer ball a repeated number of times against the wall within a given target area and from a specified distance on the floor.

Equipment.

1. Regulation soccer ball, stop watch.
2. Markings: On a flat wall space, mark a target area 4 ft. wide and 2½ ft. high which extends to the floor. A similar area is marked on the floor, 4 ft. wide and 2½ ft. long which extends from and is parallel to the wall target. The 4-ft. line on the floor, farthest from the wall target, is extended 1 ft. on either side, and constitutes the restraining line.

Test. The ball is placed back of the restraining lines at any position desired by the subject (usually toward the center of the line). On the signal "Go" the subject kicks the ball against the wall into the target area, and as it rebounds he continues to kick it repeatedly against the wall. If the ball gets out of control, the subject retrieves it himself, brings it back to the restraining line, and starts it again. The subject may not touch the ball with his hands while it is in the rectangular floor area between the restraining line and the target. If the ball stops within this area, he must remove it by using his foot. At any time that the ball is outside of this rectangular floor area, the subject may use his hands in retrieving or moving the ball.

A successful hit is one that is kicked with the foot into the target area on the wall from *behind* the restraining line on the floor. Line balls are not fair hits. To constitute a fair hit, the ball must be kicked from in back of the restraining line (not *on* it), and must land between the lines that bound the wall target.

Scoring. One point is given for each successful hit. Each time that the ball is touched with the hands when it is inside the rectangular floor area, one point is subtracted from the score. The subject is given a 15-sec. practice trial. The test administrator scores verbally during this trial, calling attention to balls that are not legal hits. This score is not recorded.

Four 15-sec. trials are given, after the practice trial. The total number of points is recorded for *each* trial. The best of the four trials is the final score for the test.

SOFTBALL REPEATED THROWS

This test measures the ability of the subject to throw a softball, using an overhand throw, into a given target area from a specified distance.

Equipment.

1. Regulation 12-in. inseam softball, stop watch.
2. Markings: On a flat wall space, mark a target area 5½ ft. wide and at least 10 ft high, at a distance of 6 in. from the floor. A throwing area, 5½ ft. square, is marked on

the floor at a distance of 9 ft. from the target and parallel to it. A back-stop, 12 ft. long and 2½ ft. high (at least) is placed 15 ft. in back of the throwing area.

Test. The subject stands at any place he chooses inside of the throwing area. On the signal "Go" he throws the ball against the wall into the target area, using an overhand throw, and continues successive throws until the signal "Stop" is given. The balls may be received from the target either on the bounce or on the fly. If the ball gets out of control at any time, the subject must recover it himself without assistance. Most of these balls will be stopped by the back-stop, but if this is not the case, the subject must chase the balls himself. A successful throw is one that is an overhand throw that goes into the target area and is made from inside the throwing area. Line balls are not fair hits.

Scoring. One point is given for each successful throw. The subject is given a ten-second practice trial. The test administrator scores verbally during this trial. This score is not recorded.

Two 15-sec. trials are given, after the practice trial. The total number of points is recorded for *each* trial. The better of the two trials is the final score for the test.

The data for this study were collected over a two-year period. Standardized equipment was used throughout the study and in all cases was supplied by the investigator. The subjects were fourth, fifth, and sixth grade boys and girls from 21 elementary schools in Iowa and from three elementary schools in Illinois. Subjects were selected from schools in cities, small towns, rural consolidated areas, and industrial areas, in an effort to obtain a cross-section of the population. Because of the limiting time factor, it was not possible to to give all seven tests to all fourth, fifth, and sixth grade children in each school included in the study. From one to six tests were administered in each school, dependent upon the time that was made available for this testing by the co-operating school.

Reliability of the tests was determined by administering the tests to approximately 50 boys and 50 girls at each grade level. The investigator administered all of these tests without assistance. The Basketball Wall Pass, Volleyball Wall Volley, Shuttle Run, and Softball Repeated Throws were given to the same subjects, under the same conditions, on two successive days, and the scores of the first administration were correlated with the scores of the second administration. The Vertical Jump was administered to the subject, and after a 10-min. rest period during which time other subjects were tested, the test was administered the second time. The scores of the first and second administrations were correlated. The Standing Broad Jump was given in three successive trials. The best trial was correlated with the second best trial to determine reliability. Four successive trials were given in the Soccer Wall Volley, and the best trial was correlated with the second best trial to determine reliability. Satisfactory reliabilities were obtained for each test by sex and by grade, and the tests were then given to the remainder of the selected population.

Face validity was used for each test; that is, the test purported to measure only the particular performance that constituted the test. Consequently, no validity coefficient is shown.

TABLE 1

Product-Moment Correlations for Reliability of Each Test by Sex and Grade

Test	BOYS						GIRLS					
	Grade IV		Grade V		Grade VI		Grade IV		Grade V		Grade VI	
	N	r	N	r	N	r	N	r	N	r	N	r
Basketball Wall Pass	50	.91	50	.84	90	.78	50	.94	47	.89	55	.83
Volleyball Wall Volley	51	.85	56	.89	53	.91	48	.88	55	.92	56	.93
Vertical Jump	51	.90	50	.92	53	.93	56	.92	55	.95	55	.95
Standing Broad Jump	65	.97	52	.94	53	.94	53	.93	54	.97	63	.86
Shuttle Run	45	.89	50	.89	57	.89	56	.84	47	.85	47	.79
Soccer Wall Volley	45	.82	50	.89	55	.88	58	.77	46	.83	46	.77
Softball Repeated Throws	47	.82	50	.77	76	.85	61	.80	47	.82	53	.85

TABLE 2

Product-Moment Correlations Between Age, Height, Weight and Each Test by Sex and for Composite of All Three Grades

Test	BOYS						GIRLS					
	Age		Height		Weight		Age		Height		Weight	
	N	r	N	r	N	r	N	r	N	r	N	r
Basketball Wall Pass	150	[1].32	142	[1].42	140	.25	177	[1].34	163	[1].31	164	[1].38
Volleyball Wall Volley	150	[1].33	139	[1].33	139	.26	171	[1].49	158	[1].33	157	[1].27
Vertical Jump	148	[1].29	137	[1].24	137	.06	158	.20	145	.06	145	—.07
Standing Broad Jump	153	[1].35	151	[1].29	152	.04	164	[1].27	146	.25	147	.07
Shuttle Run	163	[1].33	151	.07	151	—.01	162	[1].28	150	.06	150	—.07
Soccer Wall Volley	153	[1].29	143	.08	143	.09	159	[1].28	143	.17	143	.19
Softball Repeated Throws	151	[1].43	143	[1].33	143	.17	158	[1].37	146	[1].22	146	[1].31

[1]Significant at the 1-per-cent level of confidence.

Presentation of Data

Correlations for reliability were computed for each sex, in each grade, and for all seven tests, by means of the Product-Moment formula. These reliability coefficients appear in Table 1.

In an effort to determine the degree of relationship between age, height, and weight and the performance as measured by each test, correlation coefficients were computed for the boys groups, irrespective of grade level, and similarly for the girls groups (Table 2).

The hypothesis that each of these coefficients was equal to zero was tested by the formula $t = (r\sqrt{N-2})/(\sqrt{1-r^2})$ found in Edwards (1) using the conversion to F in the following equation: $F = (r^2\sqrt{N-2})/(1-r^2)$, degrees of freedom equal to 1, N−2. The hypothesis was rejected most consistently for age, and was accepted most consistently for weight.

By using the formula $z = (z'-\bar{z}')/(\sigma_z)$ found in Edwards (1), all of the obtained coefficients of correlation were found to be significantly smaller at the 1-per-cent level of confidence than a coefficient of .60.

First and second order partial correlations were computed for the boys group and for the girls group, still using the composite of all three grade levels. In the second order partials, where one factor was correlated with the test, holding the other two factors constant, it was apparent that age was again the factor which appeared to have the highest relationship with performance (Tables 3 and 4).

In an effort to determine the degree of relationship between these factors and performance within grade levels, correlation coefficients were computed between age, height, weight and each test, for each sex within each grade. All of these coefficients were below .30 and none of the coefficients were significant at the 1-per-cent level of confidence.

Significant ratios were computed between the mean scores of the three grade levels for each test, by sex. The mean scores were significantly higher at the 1-per-cent level from grade to grade for each sex and for each test, with the following exceptions:

1. The difference between fifth and sixth grade means for boys was not significant in the Vertical Jump, Standing Broad Jump, and Shuttle Run.
2. There were no significant differences between means of fourth and fifth grade girls, and fifth and sixth grade girls in the Standing Broad Jump and Shuttle Run.

Scores were recorded by age groups within each grade and for each test, by sex. The mean performance for boys for each age group within each grade was determined. Although the age factor for girls was not operating as heavily as for boys, as observed by the size of the correlation coefficients, two tests which showed the highest relationship for girls were selected and similar computations were done (Tables 5 and 6).

An analysis of variance was computed for the purpose of testing the significance of these differences. In general, the difference among age groups

TABLE 3

First and Second Order Partial Correlations for Boys, Composite of All Three Grades

Test	$r_{01.2}$	$r_{01.3}$	$r_{02.1}$	$r_{02.3}$	$r_{03.1}$	$r_{03.2}$	$r_{01.23}$	$r_{02.13}$	$r_{03.12}$
Basketball Wall Pass	.12	.25	.31	.37	.15	—.13	.11	.29	—.11
Volleyball Wall Volley	.19	.26	.19	.21	.16	.01	.19	.11	.03
Vertical Jump	.20	.29	.10	.30	—.06	—.20	.18	.21	—.19
Standing Broad Jump	.25	.37	.14	.40	—.13	—.25	.29	.29	—.29
Shuttle Run	.35	.36	—.14	.13	—.15	—.01	.35	—.05	—.07
Soccer Wall Volley	.32	.28	—.10	.02	.02	.04	.33	.17	.13
Softball Repeated Throws	.32	.40	.13	.32	.008	—.14	.31	.18	—.12

$r_{01.2}$ indicates first order partials. Performance test (0), Age (1), Height (2), Weight (3).
$r_{01.23}$ indicates second order partials.

TABLE 4

First and Second Order Partial Correlations for Girls, Composite of All Three Grades

Test	$r_{01.2}$	$r_{01.3}$	$r_{02.1}$	$r_{02.3}$	$r_{03.1}$	$r_{03.2}$	$r_{01.23}$	$r_{02.13}$	$r_{03.12}$
Basketball Wall Pass	.20	.17	.14	.03	.29	.23	.17	—.07	.26
Volleyball Wall Volley	.38	.43	.06	.20	.10	.03	.38	—.08	.08
Vertical Jump	.21	.28	—.07	.18	—.21	—.18	.25	.09	—.22
Standing Broad Jump	.15	.28	.11	.29	—.05	—.18	.18	.18	—.15
Shuttle Run	.31	.38	—.14	.18	.27	—.18	.35	.05	—.24
Soccer Wall Volley	.23	.21	.01	.04	.05	.09	.22	.03	.06
Softball Repeated Throws	.30	.25	.00	—.03	.14	.23	.27	.12	.19

$r_{01.2}$ indicates first order partials. Performance test (0), Age (1), Height (2), Weight (3).
$r_{01.23}$ indicates second order partials.

TABLE 5

Mean Performance of Each Test by Age Within Each Grade, for Boys

	Fourth Grade			Fifth Grade			Sixth Grade		
	N	M	SD	N	M	SD	N	M	SD
Age	*Basketball Wall Pass*								
9	34	14.47	2.72						
10	20	15.85	3.01	36	16.39	2.77	5	16.80	1.61
11	13	15.46	2.32	28	16.29	3.21	48	18.06	2.74
12				7	14.71	4.60	27	18.59	3.75
13							11	17.82	3.38
	Volleyball Wall Volley								
9	43	6.77	4.14						
10	34	5.88	2.79	42	8.31	3.49			
11	16	7.50	3.73	32	9.46	4.55	38	12.50	5.08
12				10	8.20	4.80	26	12.84	5.90
13							12	13.66	3.77
	Vertical Jump								
9	33	10.78	2.15						
10	23	10.82	1.64	39	10.97	2.10			
11	14	11.14	1.51	26	12.00	1.86	42	11.73	1.82
12				9	13.44	1.76	22	11.63	2.24
13							11	12.54	2.02
	Standing Broad Jump								
9	67	53.75	6.35						
10	31	54.48	7.84	53	54.92	6.98			
11	9	55.00	3.53	34	58.64	6.60	55	57.38	7.34
12				8	57.37	8.96	32	61.31	7.59
13							11	60.90	6.33
	Shuttle Run								
9	47	13.50	.24						
10	41	13.40	.32	43	13.00	.24			
11	32	13.10	.25	41	12.90	.26	58	12.50	.30
12				15	12.70	.28	60	12.40	.27
13							28	11.90	.28
	Soccer Wall Volley								
9	49	9.12	1.97						
10	37	10.17	2.33	46	9.78	2.09			
11	13	9.15	1.80	46	10.36	2.52	52	11.42	2.57
12				10	10.40	1.70	44	11.39	2.44
13							14	12.29	2.49
	Softball Repeated Throws								
9	54	7.64	1.38						
10	31	7.90	1.53	50	8.62	1.61			
11	16	7.93	1.39	38	9.34	1.09	49	10.20	2.00
12				8	9.37	1.94	48	9.85	2.30
13							13	11.53	1.52

TABLE 6

Mean Performance of Each Test by Age Within Each Grade, for Girls

Age	Fourth Grade			Fifth Grade			Sixth Grade		
	N	M	SD	N	M	SD	N	M	SD
	Basketball Wall Pass								
9	40	12.37	2.50						
10	18	13.50	2.61	43	14.34	2.25			
11	5	13.40	2.97	18	13.27	1.52	57	14.66	4.20
12							31	14.51	4.14
13							7	16.00	1.69
	Volleyball Wall Volley								
9	58	3.84	1.90						
10	31	4.96	2.64	46	5.39	2.78			
11	11	4.36	2.43	23	6.91	3.01	75	8.85	3.82
12							39	8.74	3.43
13							7	8.71	2.36

within each grade was not significant at the 1-per-cent level of confidence, the exceptions being Boys Vertical Jump, Grade V, and Shuttle Run, Grade VI. The difference was significant when all three grades were combined, with the exception of Girls Basketball Wall Pass.

The results obtained by using analysis of variance on the data in this study indicated that experience, or some form of maturation, determined the performance of the subjects measured by the given test to a greater degree than did age, height, or weight factors. Consequently, performance standards were developed for each grade level, rather than by age, height, or weight factors. The observed difference between means of boys and girls scores indicated the advisability of computing the norms separately for each sex.

Summary and Conclusions

Certain skills were selected as basic to performance in many motor activities for grades four, five, and six. These skills were running, jumping, throwing and catching, striking, and kicking. Seven tests were developed which appeared to be satisfactory measures of performance in these skill areas for boys and girls at these grade levels. T-scales and percentile ranks were computed for each test, by sex and by grade.

An analysis of the data would indicate the following conclusions:

1. The relationship between age, height, weight and performance as measured by these tests appeared to be relatively low for the subjects used in this study. Height and weight factors in general, showed a lower relationship to performance than did the age factor for both boys and girls.

2. The mean scores were significantly higher from grade to grade for each sex and for each test, with the following exceptions:

(a) The difference between fifth and sixth grade means for boys was not significant in the Vertical Jump, Standing Broad Jump, and Shuttle Run.

(b) There were no significant differences between means of fourth and fifth grade girls, and fifth and sixth grade girls in the Standing Broad Jump and Shuttle Run.

3. Age, height, and weight factors, in general, appeared to have lower relationship with performance for girls than for boys.

4. In general, the differences among the means of age groups within each grade were not significant for boys. The differences among the means of age groups for boys from grade to grade were significant at the 1-per-cent level of confidence for all tests. This would appear to indicate that experience, or some form of maturation, is a more significant factor in determining performance in these tests for the subjects measured than is age.

5. In the two tests which showed the highest relationship between age and performance for girls, the difference among age groups within grades was not significant at the 1-per-cent level. The difference from grade to grade within the same age group was significant at the 1-per-cent level of confidence for the Volleyball Wall Volley, and was not significant for the Basketball Wall Pass.

6. The mean scores for boys in each grade and for each test were higher than the mean scores for girls in the same grade.

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Achievement Levels in Basketball Skills for Women Physical Education Majors

Report of the Professional Studies and Research Committee of the Midwest Association of College Teachers of Physical Education for Women[1]

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Abstract

This study provides tables of norms in the form of T-scores and percentile rankings for raw scores made by women physical education major students on three basketball skill tests—bounce-and-shoot, half-minute shoot, and pass for accuracy. The skill tests were selected on the basis of results obtained by Leilich in an analysis of all existing basketball skill tests for women. Scores on which the tables of norms are based were obtained from very adequate numbers of subjects in a nation-wide sampling.

TEACHERS WHO ARE concerned with the professional preparation of prospective teachers of physical education are aware that there is a lack of standards by which one may judge the achievement level in activity skills reached by potential teachers. Yet one trait which writers consistently mention as being desirable in candidates for teaching in the field of physical education is an "adequate level of skill." In order to provide a yardstick by which teachers may judge the adequacy of skill level in basketball reached by individual students, the Professional Studies and Research Committee, during the year 1952-53, undertook a project to determine norms in skill in basketball for women physical education major students.

Need for the Study

A perusal of professional literature in the field discloses standards in very few activities by which it is possible to determine what constitutes an adequate level of development in skill in sports, especially suited to women students majoring in the field of physical education. In an effort to determine the advisability of undertaking the project, 50 colleges and universities in various sections of the country were contacted during the summer of 1952. Replies were received from 32 schools and, of these, 91 per cent indicated a definite interest in having such achievement norms made available. These schools also

[1]Committee members were Mary Jane Draper, Gertrude Eppler, Lura Evans, Lillian Gallichio, Beatrice Hurst, Jean May, Doris O'Donnell, Helen Sprague, Dean Summers, C. Etta Walters, Wilma K. Miller, *Chairman.*

expressed a willingness to cooperate in the project to establish the norms in the basketball skills.

Method of Procedure

Three basketball skill tests were selected for use in this study: Bounce and Shoot (2), Half-Minute Shooting (4), and Push Pass (1). These tests were chosen on the basis of their validities as revealed by Leilich's factor analysis study (3) of all basketball tests appearing in the literature, and designed for use with college women. Leilich found four factors to be basic to these tests: basketball motor ability, speed, ball handling involving passing accuracy and speed, and ball handling involving accuracy in goal throwing. The three tests were selected because of their correlations with these four factors.

Leilich's study revealed that the Bounce and Shoot test had a correlation of .634 with the basketball motor ability factor, which was the highest correlation shown by any test with this factor. The correlation of this test with passing accuracy and speed was .307. The Push Pass for Speed and Accuracy showed a correlation of .763 with ball handling involving accuracy and speed, which was the highest correlation of any test with this factor. The correlation of this test with the basketball motor ability factor was .378.

The Half-Minute Shooting test correlated .598 with the factor of ball handling involving accuracy in goal throwing, which is the highest relationship shown by any of the tests with this factor. The Half-Minute Shooting test had a correlation of .475 with the speed factor, and one of .360 with the factor of ball handling involving passing accuracy and speed.

Leilich reports that an analysis of the relations of these tests with the various factors indicates that approximately 57 per cent of the variance of the Bounce and Shoot test, 83 per cent of the variance of the Push Pass test, and 76 per cent of the variance of the Half-Minute Shooting test may be attributed to the four factors. The remainder of the variance in these tests is due to other factors. Table 1 shows the correlations of these factors with the four basic factors.

TABLE 1

Correlations of the Tests with the Factors

Tests	Factors			
	Basketball Motor Ability	Speed	Ball Handling, Involving Speed and Accuracy	Ball Handling, Involving Goal Throwing
Bounce and Shoot	.634	.211	.307	.176
Push Pass	.378	.228	.763	.237
Half-Minute Shooting	.073	.475	.360	.598

Following the preliminary survey, a letter was sent to 229 colleges and universities in all sections of the country, explaining the purpose of the study and asking for co-operation in the project. Replies were received from 151 schools.

Of these, 92 indicated that they would be able to participate in the project to the extent of administering the three tests to their women students majoring in physical education. Accordingly, these schools were sent mimeographed copies of directions for administering and scoring the three tests, along with a form on which to report scores. A total of 59 schools returned scores on one or more of the three tests.

Table 2 indicates the norms for 1,812 subjects on the Half-Minute Shooting test. It will be noted that scores range from 1 to 20. The mean score was 9.11 and the standard deviation 3.50.

TABLE 2
Norms for Half-Minute Shoot Test

Raw Score	T-Score	Percentile[1]
20	81	100
19	78	100
18	75	100
17	73	99
16	70	99
15	67	97
14	64	94
13	61	89
12	58	82
11	55	75
10	53	67
9	50	57
8	47	46
7	44	35
6	41	26
5	38	17
4	35	10
3	33	5
2	30	1
1	27	1

[1]N is 1812. Mean is 9.11. S.D. is 3.50.

In Table 3 is given the distribution of scores on the Bounce and Shoot test by time in seconds. Scores on this test ranged from 41 seconds to 135 seconds, the mean score being 69.69 seconds and the standard deviation 12.00.

Table 4 provides scores for 1,645 students on the Bounce and Shoot test for accuracy. The range of scores was from 1 to 20, the mean score being 12.95 and the standard deviation 4.12.

Table 5 shows the distribution of scores for 1,646 students on the Push Pass test. Scores ranged from 44 to 160, the mean score being 96.66 and the standard deviation 13.47.

In Table 6 is given an additional means for evaluating student performance on the three tests. A standard deviation distance of 1.2 was used to determine the classifications. Attention is called to the fact that the total amount of instruction received or the total amount of experience in playing basketball was not considered in establishing these norms.

TABLE 3
Norms for Bounce and Shoot Test (Time in Seconds)

Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]
41	74	100	57	61	93	73	47	34
42	73	100	58	60	91	74	46	31
43	72	100	59	59	88	75	46	28
44	71	100	60	58	86	76	45	25
45	71	100	61	57	75	77	44	23
46	70	100	62	56	72	78	43	21
47	69	100	63	56	69	79	42	19
48	68	100	64	55	66	80	41	18
49	67	100	65	54	62	81	41	15
50	66	100	66	53	58	82	40	14
51	66	99	67	52	55	83	39	13
52	65	98	68	51	51	84	38	12
53	64	98	69	51	48	85	37	11
54	63	97	70	50	44	86	36	10
55	62	96	71	49	40	87	36	9
56	61	95	72	48	36	88	35	8
Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]
89	34	8	105	21	3	121	7	1
90	33	7	106	20	2	122	6	1
91	32	6	107	19	2	123	6	1
92	31	5	108	18	2	124	5	1
93	31	5	109	17	2	125	4	1
94	30	5	110	16	2	126	3	1
95	29	4	111	16	2	127	2	1
96	28	4	112	15	1	128	1	1
97	27	4	113	14	1	129	1	1
98	26	4	114	13	1	130	0	1
99	26	3	115	12	1	131	−1	1
100	25	3	116	11	1	132	−2	1
101	24	3	117	11	1	133	−3	1
102	23	3	118	10	1	134	−4	1
103	22	3	119	9	1	135	−4	1
104	21	3	120	8	1			

[1]Percentile. N. is 1645. Mean is 69.69 seconds. S.D. is 12.00 seconds.

TABLE 4
Norms for Bounce and Shoot Test (Accuracy)

Raw Score	T-Score	Percentile[1]
20	67	100
19	65	98
18	62	93
17	60	87
16	57	79
15	55	69
14	53	61
13	50	52
12	48	42
11	45	35

(*Continued on next page*)

TABLE 4 (*Continued*)

Raw Score	T-Score	Percentile[1]
10	43	28
9	40	21
8	38	16
7	36	11
6	33	9
5	31	6
4	28	4
3	26	2
2	23	2
1	21	1

[1]N is 1645. Mean is 12.95. S.D. is 4.12.

TABLE 5

Norms for Push-Pass Test

Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]
160	97	100	142	84	100	124	70	99
159	96	100	141	83	100	123	70	99
158	96	100	140	82	100	122	69	99
157	95	100	139	81	100	121	68	99
156	94	100	138	81	100	120	67	99
155	93	100	137	80	100	119	67	97
154	93	100	136	79	100	118	66	97
153	92	100	135	78	100	117	65	96
152	91	100	134	78	100	116	64	96
151	90	100	133	77	100	115	64	96
150	90	100	132	76	100	114	63	93
149	89	100	131	76	100	113	62	93
148	88	100	130	75	100	112	61	91
147	87	100	129	74	100	111	61	91
146	87	100	128	73	100	110	60	90
145	86	100	127	73	100	109	59	86
144	85	100	126	72	100	108	58	85
143	84	100	125	71	100	107	58	82
106	57	81	85	41	18	64	26	3
105	56	79	84	41	16	63	25	3
104	55	72	83	40	15	62	24	2
103	55	71	82	39	14	61	24	2
102	54	66	81	38	13	60	23	2
101	53	65	80	38	12	59	22	2
100	52	62	79	37	10	58	21	2
99	52	55	78	36	9	57	21	2
98	51	53	77	35	8	56	20	1
97	50	47	76	35	8	55	19	1
96	50	47	75	34	7	54	18	1
95	49	44	74	33	6	53	18	1
94	48	39	73	32	5	52	17	1
93	47	37	72	32	5	51	16	1
92	47	32	71	31	4	50	15	1

(*Continued on next page*)

TABLE 5 (*Continued*)

Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]	Raw Score	T-Score	Perc.[1]
91	46	31	70	30	4	49	15	1
90	45	28	69	29	3	48	14	1
89	44	25	68	29	3	47	13	1
88	44	24	67	28	3	46	12	1
87	43	21	66	27	3	45	12	1
86	42	20	65	26	3	44	11	1

[1]Percentile. N is 1646. Mean is 96.66. S.D. is 13.47.

TABLE 6

Classification of Raw Scores on the Tests

Classification	Raw Scores			
	Bounce and Shoot (*Accuracy*)	Bounce and Shoot (*Time in Seconds*)	Push Pass	Half-Minute Shooting
Superior	21 and above	47 and below	122 and above	16 and above
Good	16-20	48-61	106-121	12-15
Average	10-15	62-77	89-105	7-11
Fair	6- 9	78-91	72-88	3- 6
Poor	5 and below	92 and above	71 and below	2 and below

Summary

The purpose of this study was to determine achievement levels in basketball skills based on the accomplishments of women students majoring in physical education in colleges and universities located in all sections of the country. The three tests selected for use were chosen on the basis of results obtained by Leilich in a factor analysis study covering all skill tests in basketball appearing in the literature.

Norms in the form of T-scores and percentile ranks have been determined, based on the achievements of a very adequate number of subjects. It is expected that the tables of norms provided by this study will be of considerable aid to teachers in the professional physical education curriculum, in judging the adequacy of achievements of their students in basketball skills, and will be of assistance to students in diagnosing their own strengths and weaknesses in this activity.

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Relation of Kinesthetic Perception to Motor Learning

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Abstract

In this investigation, 115 college women were tested on 12 positional measures of kinesthesis. Each woman was classified as a fast or slow learner on the basis of the improvement shown during 24 class periods of bowling.

Differences between the mean kinesthetic scores were tested for the fast and slow learning groups and for the entire group between preferred and non-preferred arms.

The results of the study indicate that: (1) There is a relationship between motor learning and positional measures of kinesthesis; (2) The kinesthetic sense is more important in the early stages of learning a motor skill than in the later stages; (3) There are real differences between the preferred and non-preferred arms in kinesthetic perceptivity.

THE PRIMARY PURPOSE of this investigation is to determine whether or not positional measures of kinesthesis[1] are related to a motor skill, and if so, whether the relationship is more evident in the early stages of acquiring the skill than in the later stages. A secondary purpose is to discover whether or not there are any differences in kinesthetic perception in the preferred and non-preferred arms.

An increasing interest in the kinesthetic sense is being evidenced by research investigators in the field of physical education. Since 1950, eight completed Master's and Doctor's theses, known to the authors, have been concerned with some phase of kinesthetic perception, while previous to that time only a scattering of such investigations were undertaken.

A summary of researches in this area reveals some interesting findings. Five investigators, all working with women, report on the relationship found between measures of kinesthesis and tests of general motor ability. Fisher (4), Stevens (17), and Young (22) found either no relationship or very low relationships present; however, Roloff (14) reports a correlation of .42 between a battery of four tests of kinesthesis and scores on the Scott Motor Ability Test. Norrie (11) found that for women selected because they are at the extreme levels in general motor performance there is a significant difference in kinesthetic judgment, particularly in those phases concerned with force control and balance.

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[1]Kinesthetic perception is defined for the purposes of this study as "the conscious awareness of the individual of the position of the parts of the body during voluntary movement."

Differences in kinesthetic perception were found by five investigators when comparing groups with different amounts of motor training or varying degrees of success in specific motor activities. Kerr and Weinland (6) offer some evidence that men athletes are superior to non-athletes in their ability to judge force of muscular contractions and that muscular perceptivity is a factor in skilled hand work. Wiebe (20) also found significant differences in kinesthetic measures between men athletes and non-athletes. Stevens (17) reports significant differences between women majors in physical education and non-majors. Filer (3) found that kinesthetic measures differed significantly between successful and non-successful musicians and Taylor (18) secured similar results for successful and unsuccessful basketball players. In all cases the more highly trained or successful individuals were superior. Wettstone (19), however, found the relation between kinesthetic tests and tests of gymnastic ability to be negligible. Young (22) reports low relationships between leg positioning and kicking accuracy, and none between arm positioning movements and throwing and hitting accuracy.

Four investigators concerned themselves with the relationship between learning a motor skill and kinesthetic perception. Roloff (14) reports no relationships between tests of kinethesis and final bowling and tennis performances following an eight-week instruction period. Lindsay (7) found low positive correlations between kinesthesis and learning a motor skill involving rolling a ball at a target. Phillips' (12) and Smith's (15) results offer the most substantial evidence of a relationship existing between kinethesis and motor learning. Phillips found correlations of .505 and .422 between a battery of four tests of kinethesis and putting and driving scores in golf following a period of instruction. Smith, working with elementary school children, found significant differences between positional measures of kinethesis for fast- and slow-learning groups on two motor skills.

Methods of teaching in which awareness of the kinesthetic sense is emphasized do not appear to be more effective in improving learning than do the more conventional approaches. Coady (2) found that golf skills were not significantly improved by these techniques and McGrath (8) found the same to be true in teaching free-throw shooting.

Individuals who have administered various tests of kinesthesis to groups have been aware that kinesthesis may not be thought of as a general sense but as specific to the part of the body being tested and to the nature of the test. Intercorrelations between tests designed to measure kinesthesis are consistently low or negligible, except where the tests themselves are quite similar. The strongest evidence to support this has been offered by Witte (21), who completed a factor analysis of 33 tests of kinesthesis and identified seven factors basic to the tests.

Meday (9) provides some information on the effect of practice on kinesthetic discrimination. The results of the study showed that significant differences exist between scores before and after practice on tests designed to measure perception of force and direction of movement.

Roloff (14), Stevens (17), and Wiebe (20) have developed batteries of tests for the purpose of predicting kinesthetic discrimination as measured by a variety of tests.

The most recent studies to appear are those by Henry (5) and Mumby (10). Henry describes a kinesthetic test apparatus and reports the results of his testing. The tests were concerned with the accuracy of adjustment to varying pressures and perception of pressure change. Data collected for 12 male subjects show a fairly close correspondence between the adjustment and perception measures, in terms of accuracy of response. Mumby used the apparatus described by Henry to test the relationships between measures of kinesthesis and wrestling ability. He found that a significant relationship exists between accuracy of adjustment to varying pressures and wrestling ability.

Procedure

The motor skill selected for the purpose of this study was bowling. This is an activity that is taught in many physical education programs and it lends itself to objective measurement. Positional measures involving arm movements were used to test kinesthesis as the primary muscular control in bowling skill is in the arms, and positional measures provide an objective and reliable[2] test. The movements were selected so as to include some movements that are similar to those made in performing every day activities and some movements that the average individual rarely would be making. The 0° to 90° movements were considered to be primarily of the first type and the 180° to 75° and 120° to 25° primarily of the second type. The 0° to 130° movements were considered to be between the two. The 90° to 40° movement was included because it simulated the backswing in bowling.

The subjects for the study were 115 women enrolled in bowling classes taught by the Women's Physical Education Department at Indiana University during the school year 1952-53. These classes met twice a week for six weeks and two lines were bowled at each class period.

TEST EQUIPMENT

One pair of non-shatterable rubber goggles with an adjustable head band. The lenses are blacked out with black poster paint.

Four finger pointers cut from thin copper sheet (Figure IA). Bands of the pointers should be of various lengths for adjustment to different-sized fingers. Bands bend to clamp on fingers.

One photoflood lamp with clamp on attachment and several number two photofloods. One stand approximately six feet in height to support the flood lamp.

One five-foot-square measuring board constructed from ¼-inch plywood, and reinforced on the back with ¼-inch by 2-inch strips, to prevent warping. A circle with a 28-inch radius is constructed on the face of the board. The

[2]Wiebe (20) reports a reliability of .91 for both arm and leg positional measures.

0° point is marked at the exact bottom and the 180° point at the exact top of the circle. Radii are constructed at each whole degree and both halves of the circle are numbered from 0° to 180°. Radii which are either starting or finishing points for the tests are marked in red. This board is suspended on the wall by a system of hooks and pulleys and anchored by a windlass set in a wooden block, thus the board is adjustable to the varying heights of subjects (Figure IB).

Three 1-inch by 12-inch black lines are painted on the floor. The middle line is directly below the center point of the board, the other two are parallel to the middle line and 13 inches from it. These lines are for guiding the placement of the subject's feet.

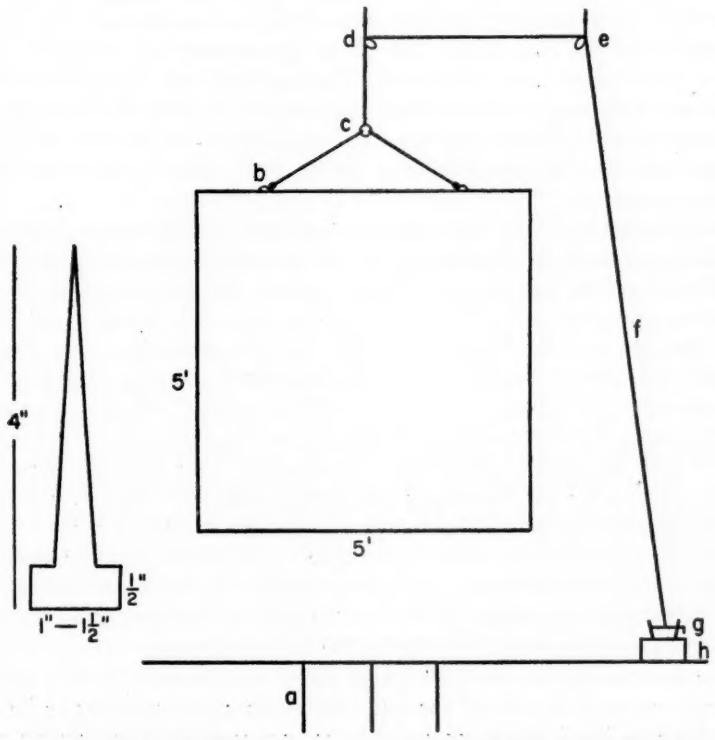

FIGURE IA. Finger Pointer

a. foot marks
b. harness snap and hook
c. swivel snap
d. pulley and hook

FIGURE IB. Measuring Board

e. pulley and hook
f. window cord
g. windlass
h. wooden block

The stand supporting the floodlamp is placed directly opposite the center of the measuring board and six or seven feet back from it. This should be adjusted in terms of the distance which produces the most distinct shadow on the board. The lamp should be clamped to the stand at a height which would direct the center rays exactly on the center of the board.

ADMINISTRATION OF TESTS

The general nature of the investigation was explained to the members of the bowling classes and then each subject was approached individually and asked to participate in the study.[3] All of the girls agreed to co-operate and all tests were administered outside of class time.

Two rooms were utilized for the testing, one to greet the subject and prepare her and the other for the actual administration of the tests. The subject reported to the outer testing room and was given a brief orientation to the nature and purpose of the study, but no information on the actual testing procedure. The subjects had been instructed to wear flat-heeled shoes and a blouse or sweater and skirt. The blouse or sweater was removed so as to insure unrestricted arm movements. Each subject was blindfolded with the goggles and a new piece of Kleenex was inserted between the face and glasses for each subject. Finger pointers were attached to the index fingers and the subject was then led into the inner testing room which contained the actual testing equipment.

The measuring board was adjusted for each subject so the center of the board was exactly at shoulder level. In all movements designated as "side arm," the subject was placed with her back to the measuring board. If the movement was executed with the right arm, the right shoulder was lined up with the center of the board, the right foot placed on the center foot mark, the left foot on the left foot mark. A comparable position was assumed for left-side arm movements, only with the left shoulder lined up with the center of the board. In all movements designated as "forward arm," the subject was placed with her side to the board, the shoulder lined up with the center of the board and the feet straddling the center mark. For right-arm movements the right side was towards the board and the left for left-arm movements. In all positions, the subject stood approximately 4 inches from the board.

The overhead lights in the room were turned off and the floodlamp turned on. This caused a distinct shadow to be cast on the measuring board, thus permitting very accurate readings to the nearest degree.

The first movement was with the preferred arm, side 0° to 90°. When the subject was properly placed she was told which arm was going to be moved, that this arm, hand, and fingers should be kept as straight as possible and that the arm should be turned out so the palm was facing outward. She was then

[3]Acknowledgement is made to Janet McAuley, instructor, and Virginia Hoffman, graduate assistant, both of Indiana University, for their invaluable assistance in contacting students and making testing appointments.

told the arm was going to be moved into a certain position which she was to hold for two or three seconds, following which her arm would be returned to the starting position. She would then attempt to repeat the movement and hold the position, all without assistance, and then on instruction relax the arm at the side. One of the investigators guided the assisted arm movement, by placing one hand lightly under the subject's wrist and the other under her elbow. When the movement was completed and the subject was instructed to hold the position, the investigator dropped her hands from the subject's arms.

For all movements that did not start at the 0° position, the arm was first moved into the starting position and the subject was instructed that this was the starting position for the movement. At no time was any information given the subject as to the nature of the movement or as to the success she had in reproducing the movement.

Three consecutive trials were given for each movement. The score on a trial was the number of degrees' variation from the desired position, read by means of the shadow cast by the finger pointer. The score on the test for each movement was the average of the three trials, and the smaller the score the better the kinesthetic perception.

Both of the investigators were present at all testing periods. One gave the directions and guided the subject and the other scored the results. Every effort was exerted to keep the testing conditions constant and to provide the same amount of motivation for each subject.

The tests were administered in the order in which they appear in Table 1. The order was arranged so that three tests could be given consecutively without changing the standing position of the subject, and so that no preference was given consistently to either the preferred or non-preferred arm in performing the movements.

The starting positions and number of degrees moved for the six different measures were as follows:

1. Side arm movements, 0° to 90°. The arm starts at the 0° position on the board and moves upward 90° to the 90° position on the board.

2. Side arm movements, 180° to 75°. The arm starts at the 180° position on the board and moves downward 105° to the 75° position on the board.

3. Side arm movements, 0° to 130°. The arm starts at the 0° position on the board and moves upward 130° to the 130° position on the board.

4. Forward arm movements, 90° to 40°. The arm starts at the 90° position on the board and moves 130° down past the 0° position on the board and up to the 40° position on the board.[4]

5. Forward arm movements, 120° to 25°. The arm starts at the 120° position on the board and moves downward 95° to the 25° position.

[4]Both investigators helped guide this movement. One stands in front of the subject and guides her arm to the 0° position, the other stands behind the subject and guides her arm to the 40° position.

6. Forward arm movements, 0° to 90°. The arm starts at the 0° position and moves upward 90° to the 90° position.

MOTOR LEARNING CRITERION

It had been found in a previous study by the authors (13) that bowlers classified according to their beginning levels were significantly different from each other in bowling skill at the end of 25 lines of bowling. The subjects in this study were, therefore, classified according to their beginning levels. The average of the first 12 games bowled was used for this purpose. All subjects whose averages were between 50-59.9 were considered as one ability level, those whose averages were between 60-69.9 were a second ability level, and so on for every 10 points difference. Each subject bowled a total of 24 lines during class periods and daily scores were recorded.

Improvement in learning was evaluated by the difference between the first 12-game average and the final 12-game average. Local norms based on scores collected over a period of several years had been established on this basis for each of the beginning levels of ability. Each subject received a final classification as either a "fast learner" or "slow learner" according to whether she was above the mean improvement or below the mean improvement in her ability group. Subjects whose scores fell directly at the mean or within $.15\sigma$ of the mean were not included in either of these categories. This procedure eliminated 18 subjects from the "learning" groups, reducing the total number to 96, 47 classified as fast learners and 49 classified as slow learners.

ORGANIZATION OF THE DATA

Means and standard deviations were calculated for the 115 subjects on each of the 12 measures of kinesthesis. The null hypothesis for the difference between means of the fast and slow learners was tested for each of the measures of kinesthesis and for various combinations of the measures. For purposes of combining scores on different measures to form kinesthesis batteries, the raw scores were converted to T-scores.

The relationship between kinesthesis and motor learning was determined through the biserial correlation technique.

The subjects had been classified into ability levels according to their beginning 12-game bowling average. The null hypothesis was tested for the difference between the mean kinesthetic scores of the fast and slow learners at each of the ability levels. The battery of tests 1, 7, 8, 10, and 12 was used as the measure of kinesthesis. The lowest three ability levels were combined and the highest two were combined in order to increase the size of the samples, since very few subjects were at the extreme levels. All samples in these subdivisions were small, hence the null hypothesis was also tested for the difference between the variances.

The null hypothesis was tested for the difference between the means of the preferred arm and the non-preferred arm on like measures. Since relationships were found to exist between these measures for the preferred and non-

preferred arms, the standard error of the difference for related groups was used. Relationships were established through the product moment method of correlation.

Discussion of Results

For the purposes of this study, 96 college women were classified as either fast or slow learners on the basis of the amount of improvement made in bowling during 12 class periods. Each of these women was measured on 12 tests of kinesthetic perception involving arm movements.

Table 1 gives the results of testing the null hypothesis for the difference between means of the fast and slow learners on each of the kinesthetic tests.

Examination of the means (the lower the mean value, the better the kinesthesis score) shows that in every instance but one, the difference favors the

TABLE 1

Values of t for the Difference Between Means of Fast and Slow Learners, on Individual Kinesthetic Measures

Test	Group	M	σ	σM	σdiff.	t
Preferred arm, side						
1. 0°-90°	F (N=47)[1]	3.43	2.01	.293	.403	1.22
	S (N=49)[2]	3.92	1.92	.277		
2. 180°-75°	F	7.51	4.37	.644	.918	.87
	S	8.31	4.53	.654		
3. 0°-130°	F	5.68	3.23	.476	.730	.08
	S	5.74	3.84	.554		
Non-preferred arm, forward						
4. 90°-40°	F	5.52	3.69	.544	.729	1.03
	S	6.27	3.36	.485		
5. 0°-90°	F	3.64	1.77	.261	.388	.10
	S	3.60	1.99	.287		
6. 120°-25°	F	7.11	3.39	.500	.808	.67
	S	7.65	4.40	.635		
Preferred arm, forward						
7. 0°-90°	F	3.59	1.68	.248	.438	2.17
	S	4.54	2.51	.362		
8. 120°-25°	F	6.88	4.20	.619	.863	1.23
	S	7.94	4.17	.602		
9. 90°-40°	F	4.02	1.89	.279	.414	.75
	S	4.33	2.13	.307		
Non-preferred arm, side						
10. 0°-130°	F	5.30	2.96	.436	.721	1.29
	S	6.23	3.98	.574		
11. 180°-75°	F	5.96	3.11	.459	.718	1.06
	S	6.72	3.83	.553		
12. 0°-90°	F	3.80	1.71	.252	.389	2.90
	S	4.93	2.05	.296		

[1]F—fast learners.
[2]S—slow learners.

fast-learning group. The one exception is Test 5, which has a very small difference favoring the slow learning group ($t = .10$). Only two of the differences are significant, these are for tests 7 and 12. Test 7 involves the preferred arm moving from the 0° to the 90° forward arm position. The t-value for the difference between the means of the two groups on this test is 2.17, which is significant beyond the 5-per-cent level of confidence. Test 12 involves the non-preferred arm moving from the 0°-90° side arm position. The t-value for the difference between the means of the two groups on this test is 2.90, which is significant beyond the 1-per-cent level of confidence.

The values of the means in Table 1 also reveal the comparative accuracy with which the subjects were able to reproduce each of the movements. The 0° to 90° movements were most accurate, then the 90° to 40° followed by 0° to 130°, with the 180° to 75° and 120° to 25° movements the least accurate. It might be thought that the range of movement would be the most important factor in determining accuracy, but this does not seem to be the case. The range of movement for each of the measures listed in order of the accuracy of performance is 90°, 90°, 130°, 130°, 105°, 95°. The order of performance, with the possibility of fatigue entering in, is another factor which might be thought of as being related to the accuracy of performance. However, this is disclaimed when it is noted that one of the most accurate movements is the last one performed and one of the least accurate is the second one performed, and that there is not any consistent pattern between these extremes.

The one factor that does appear to be related is the familiarity of the movement. By familiarity is meant a movement that is similar to one customarily performed during everyday activities or one that has been practiced. The 0° to 90° movements are familiar from the standpoint of daily use, the 90° to 40° movements simulate the bowling backswing hence had been practiced by all the subjects. The 0° to 130° movement is somewhat less familiar and the 180° to 75° and 120° to 25° movements would both be quite strange in terms of either practice or habitual daily movements.

Various combinations of the kinesthetic measures were tested under the null hypothesis. Composite scores were secured by T-scoring the kinesthetic tests and finding average T-scores. The two tests with the highest t-values formed the first composite score. The successive composite scores were developed by adding the tests with the next highest t-values.

Table 2 gives the results of testing the null hypothesis for the difference between means of the fast and slow learners on various combinations of the kinesthetic tests.

The mean values for the two groups reveal that in all cases the fast-learning group is superior to the slow-learning group for the composite scores. In all cases the differences are significant, five combinations being significant beyond the 1-per-cent level of confidence and one (combination of all 12 tests) beyond the 5-per-cent level. A comparison of the t-values in Table 2 shows

TABLE 2

Values of t for the Difference Between Means of Fast and Slow Learners, on Composite Kinesthetic Measures

Test	Group	M	σ	σM	σdiff.	t
7, 12	F(N=47)[1]	52.47	5.99	.883	1.456	3.06
	S(N=49)[2]	48.02	8.02	1.157		
7, 10, 12	F	52.11	5.18	.764	1.243	3.10
	S	48.26	6.77	.977		
1, 7, 10, 12	F	52.34	4.48	.646	1.096	3.19
	S	48.86	6.01	.886		
1, 7, 8, 10, 12	F	52.15	4.08	.601	.994	3.31
	S	48.86	5.49	.792		
1, 4, 7, 8, 10, 11, 12	F	51.85	3.97	.883	1.456	3.06
	S	48.88	5.42	1.157		
All 12	F	51.49	3.56	.524	.823	2.16
	S	49.71	4.39	.633		

[1]F—fast learners.
[2]S—slow learners.

that up to a certain point the addition of more tests to the composite score increases the t-value; after that point the addition of more tests decreases the t-value. The combination of tests which most significantly differentiates the two groups is the one which includes tests 1, 7, 8, 10, and 12. The t-value for this combination is 3.31.

The relation between kinesthesis as measured by this composite score and motor learning as measured by bowling improvement was determined by the biserial correlation technique. A correlation of .404 was found between the two variables. This result agrees with that of Bernath Phillips (12) who found correlations of .505 and .422 between a battery of kinesthesis tests and putting and driving scores in golf. It disagrees with results of Roloff (14), who found no relationship between her measures of kinesthesis and bowling improvement. This may be due to the fact that Roloff did not classify her bowlers according to their beginning level of ability, but used absolute improvement as the criterion.

The standard deviations in Table 2 reveal that in all cases the slow-learning group tends to be more variable in kinesthesis than the fast-learning group. An examination of the distribution of scores reveals further that an individual who is a fast learner is much more likely to have an above-average kinesthesis score than a below-average one. Only 23 per cent of the fast learners had kinesthesis scores (based on composite 1, 7, 8, 10, 12) below the general mean T-score value of 50. However, the reverse does not hold true for the slow learners, since 49 per cent of them had kinesthsis scores above the general mean T-score value of 50. It would appear that if an individual is a fast learner in bowling he is almost likely (better than three out of four times) to have an above-average kinesthetic perception; however, if he is a slow learner he is almost as likely to be above average as below average in kinesthesis. This statement should be qualified by mentioning the fact that

while the slow learner has almost an even chance of being above average in kinesthetic perception, he is not in general going to be as high above average as the fast learner.

The question was posed as to whether or not the kinesthetic sense is more important in the early stages of learning as compared to the later stages. If the assumption may be accepted that individuals who are in the lower ability levels at the beginning of the instruction period are more likely to be the beginners in bowling, then there is some evidence in answer to this question. The results presented in Table 3 give the values of t for the difference between the mean kinesthetic scores of fast and slow learners at various levels of bowling ability.

TABLE 3

Values of t for the Difference Between the Mean Kinesthetic Scores of Fast and Slow Learners at Various Levels of Beginning Bowling Ability

Ability Level	Group	M	σdiff	t	F
50- 79.9	F(N=4)[1]	54.0	3.00	2.00	2.34
	S(N=13)[2]	48.0			
80- 89.9	F(N=12)	51.8	2.22	4.01	4.04
	S(N=7)	42.9			
90- 99.9	F(N=19)	51.6	1.44	.21	1.08
	S(N=11)	51.3			
100-109.9	F(N=7)	52.9	2.66	1.09	1.77
	S(N=9)	50.0			
110-120.9	F(N=5)	52.4	2.68	.63	1.74
	S(N=9)	50.7			

[1]F—fast learners.
[2]S—slow learners.

It can be seen that all differences favor the fast learners. The t-value for the lowest ability level is 2.00, not quite high enough to be significant at the 5-per-cent level of confidence, but significant beyond the 10-per-cent level. The F for this level was not significant. The t-value for the next ability level is 4.01, but since F is also significant the t-test is invalidated. Hence, the difference between means was tested with no hypothesis postulated concerning the variances (16:83). The t was found to be significant beyond the 1-per-cent level. The t and F values for the three highest ability levels do not reveal significant differences in any case. It would appear from these results that the kinesthetic sense may be more related to learning in the early stages of acquiring a skill than in the later stages.

Table 4 gives the results for testing the null hypothesis for the difference between means of preferred and non-preferred arms on the kinesthetic measures.

The mean differences in Table 4 show there is no general pattern to the differences, since three favor the preferred arm and three favor the non-preferred arm.

Three of the t-values for these differences are significant. The preferred

TABLE 4

Values of t for the Difference Between Means of Preferred and Non-Preferred Arms, on Individual Kinesthetic Measures

Test	Arm	M	σ	σM	σdiff.	r	t
Side arm							
	P[1]	3.89	2.16	.201			
0°-90°	N (N=115)[2]	4.52	2.31	.215	.241	.332	2.61
	P	8.09	4.37	.408			
180°-75°	N	6.48	3.68	.343	.514	.323	3.13
	P	6.00	4.07	.379			
0°-130°	N	5.89	3.69	.344	.363	.499	.30
Forward arm							
	P	4.08	2.18	.203			
0°-90°	N	3.72	2.05	.191	.236	.284	1.52
	P	7.73	4.75	.443			
120°-25°	N	7.78	4.26	.397	.476	.362	.11
	P	4.40	2.47	.230			
90°-40°	N	5.99	3.59	.335	.400	.033	3.98

[1]P—preferred arm.
[2]N—non-preferred arm.

arm is significantly superior to the non-preferred arm on the 0° to 90° side arm movement, at better than the 2-per-cent level of confidence. The preferred arm is also significantly superior on the 90° to 40° forward arm movement, this time at better than 1 per-cent level. The only movement in which the non-preferred arm is significantly superior to the preferred arm is the 180° to 75° side arm movement, and is significant beyond the 1-per-cent level.

It is difficult to rationalize these findings, since it might have been anticipated that real differences would occur in one direction only. There is one factor, however, that may be observed about the three movements, which may offer a possible explanation. The non-preferred arm was superior in the 180° to 75° movement. This is a movement quite foreign to any that an individual would habitually be making. The preferred arm was significantly superior in the 0° to 90° side arm movement and the 90° to 40° forward arm movement. The side arm movement is common to many of our everyday activities and the forward arm movement was selected specifically because it simulated the swing used in bowling. The 90° to 40° movement is one that all of the subjects are known to have been performing in their bowling and is the movement which best differentiated between the preferred and non-preferred arms. It is possible then, that when a movement is one that is familiar from the standpoint of being common to daily activities, the arm that customarily makes that movement will be superior in duplicating the movement through the kinesthetic sense. When a movement is strange, however—that is, not made customarily by either arm—the non-preferred arm will be superior in duplicating that movement through the kinesthetic sense. A stronger case could have been presented for this line of reasoning had the other movements followed the same trend.

Referring again to Table 4, it will be noted that the 90° to 40° movement is the only one that shows no correlation between the preferred and non-preferred arms. This may constitute some evidence that when a movement is practiced, the kinesthetic perceptivity of the arm for performing that movement is affected.

Summary and Conclusions

This investigation was planned to provide some evidence in answering three questions: 1. Are positional measures of kinesthesis related to learning a motor skill? 2. If a relationship exists between the kinesthetic sense and motor learning, is the relationship more evident in the early stages of acquiring a skill than in the later stages? 3. Are there differences in the kinesthetic perception of the preferred and non-preferred arms?

The subjects for the study were 115 college women enrolled in bowling classes at Indiana University. Twelve positional measures of kinesthesis were administered to each subject, and each subject was classified as a fast or slow learner according to her bowling improvement.

The results indicate that there is a relationship between motor learning, as evaluated in this study, and positional measures of kinesthesis. This conclusion is supported by significant differences found to exist between the mean scores of the two groups (fast learners and slow learners) on two of the kinesthesis tests and several combinations of the tests. It is supported further by a biserial correlation of .404 between the learning criterion and a combination of the kinesthesis measures.

There is some evidence to support the hypothesis that kinesthesis is more related to learning in the early stages of acquiring a motor skill than it is in the later stages. The differences between the fast and slow learners among the beginning bowlers were either highly significant or very close to the 5-percent level, while the differences between the fast and slow learners for the more advanced bowlers were not significant.

Real differences between the preferred and non-preferred arms in kinesthetic perceptivity are also indicated. It would appear from the evidence that the superiority of the preferred or non-preferred arm on any given movement may be influenced by whether or not the individual habitually uses the movement or one similar to it. Whether or not the movement is one used in daily activity also appears to affect the accuracy with which the movement can be reproduced through the kinesthetic sense.

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Some Aspects of Evaluation in a Health Education Workshop [1]

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Abstract

This study attempted to determine not only the change in health knowledge evidenced by 62 participants in a three-week health education workshop but also the relationship between each student's knowledge and the rating of his contribution to a workshop situation, as measured by staff and fellow workshop members. It was concluded that there was considerable gain in health knowledge. However, although there was substantial agreement between instructor and fellow student ratings as to the contribution of a particular individual to the workshop, there was apparently little relationship between his knowledge as measured by standardized test scores and the above ratings.

AS PART OF his assignment as consultant to a Health Education Workshop, the senior author of this article was asked to attempt some evaluation of the program. Several things were undertaken including weekly student and faculty evaluations of the progress of the workshop from which summaries were made and the results used in planning the following week's program.

Purpose of Study

Three evaluation procedures attempted lend themselves to statistical treatment and were considered of sufficient interest to report. They were:

1. An attempt to measure actual increase (or decrease) of health knowledge using a standardized health knowledge test for pre-testing and post-testing in the workshop.
2. An attempt to determine the relationship which exists between peer and instructor ratings of the contribution of individuals to the workshop.
3. An attempt to determine the relationship which exists between health knowledge and the contribution of an individual to the workshop as measured by student and staff ratings.

Procedure

There were 62 students enrolled in the workshop, the majority of whom were elementary school teachers or nurses. For purposes of facility of operation on special projects, the workshop was subdivided into four smaller groups, each of which had a full-time staff member assigned to work with it.

[1]The data for this study were collected at a Health Education Workshop held at Pennsylvania State College, June 9-26, 1953. Dr. Arthur Harnett was director of the Workshop.

The groups were designated as:

Name	*No. of Participants*
Group A	17
Group B	15
Group C	15
Group D	15

About half the class time in the Workshop was spent in working in these groups and the remainder of the time the Workshop met as one unit.

In an attempt to measure the change, if any, in health knowledge, Form A of the Shaw-Troyer Health Knowledge Test[2] was administered to the entire membership at the first meeting of the Workshop (Tuesday afternoon, June 9) and Form B of the same test was administered at the end of the Workshop (Thursday morning, June 25).[3] In both instances the tests were corrected and returned the following day, at which time the questions were discussed and the tests collected following the discussion. (The participants were informed when the first test was given that the purpose was to discover their present knowledge in the field. When the second test was administered they were told the purpose was to measure the group's gain in knowledge.) In each instance, they were assured the scores would in no way be used as a basis for grading. They were encouraged to do their best both times in order to present a true picture of their knowledge.

The participants enjoyed taking the tests and, as might be expected, considerable discussion of certain items resulted.

Before administering the second test, the group was asked whether they wanted to take it and all were in favor of doing so.

The results of the two tests were assembled and compared both as to raw scores and percentile rank. Total group gain in both scores and percentiles were then figured (see Table 1).

In attempting to determine the relationship which exists between a participant's health knowledge and his contribution to the workshop, each staff member was asked on the next to the last day of the workshop if he would rate his group from 1 on up[4] in accordance with what contribution he thought each member had made to the total workshop situation. He was also asked to have each participant rate all participants in his group. Although the instructors had a little forewarning that they were to rate students, the participants had none. They were presented with a typed list of the names of members of their group and asked to rate them after an explanation of the reason

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[2]Shaw-Troyer Health Education Test: Knowledge and Application, Rockville Center, New York: Acorn Publishing Co., Form A, 1946, Form B, 1948.

[3]Only 59 people took both tests and so Table 1 shows only 59 participants. Two missed the first test and one the second and so could not be included.

[4]A rating of 1 represented greatest contribution of any individual in the group, 2 next, and so on.

for the rating. Therefore, they had no chance to collaborate in making their judgments. In order to insure anonymity in replies, students were urged to rank everyone in their group including themselves and not to sign the sheets. The mean for each individual in the group was figured and members were then ranked from 1 to 15 or 17 in terms of their mean score (See Table 3, Column 1).

The product-moment correlation of instructor ratings and mean peer ratings was figured to determine an answer to the second question. The correlation between mean peer ratings and the results of Test A and Test B was then determined in order to secure an answer to the third question.

TABLE 1

Raw Scores and Percentile Ranks of Students on Form A and B of the Shaw-Troyer Test and the Change in Raw Score and Percentile Rank for the Tests

Test A		Test B		Change in Raw Score Between Test A and B	Change in Percentile Rank Between Test A and B
Participant's Raw Score	Participant's % Rank	Participant's Raw Score	Participant's % Rank		
87	91	87	91	0	0
79	81	87	91	+ 8	+10
79	81	85	91	+ 6	+10
81	81	85	81	+ 4	0
70	51	77	71	+ 7	+20
79	81	80	81	+ 1	0
70	61	82	81	+12	+20
73	61	83	81	+10	+20
64	31	76	71	+12	+40
53	0	68	41	+15	+40
82	81	73	61	− 9	−20
78	81	84	81	+ 6	0
85	81	89	91	+ 4	+10
81	81	80	81	− 1	0
71	61	79	81	+ 8	+20
81	81	84	81	+ 3	0
78	81	81	81	+ 3	0
77	81	82	81	+ 5	0
69	51	80	81	+11	+30
79	81	87	91	+ 8	+10
78	81	83	81	+ 5	0
80	81	82	81	+ 2	0
85	81	89	91	+ 4	+10
81	81	86	91	+ 5	+10
89	91	92	91	+ 3	0
72	61	74	71	+ 2	+10
76	71	82	81	+ 6	+10
88	91	88	91	0	0
80	81	89	91	+ 9	+10
67	41	73	61	+ 6	+20
80	81	81	81	+ 1	0
72	61	91	91	+19	+30
72	61	76	71	+ 4	+10

TABLE 1 (*Continued*)

Test A		Test B		Change in Raw Score Between Test A and B	Change in Percentile Rank Between Test A and B
Participant's Raw Score	Participant's % Rank	Participant's Raw Score	Participant's % Rank		
72	61	86	91	+14	+30
81	81	92	91	+11	+10
65	31	79	81	+14	+50
90	91	88	91	− 2	0
65	31	75	71	+10	+40
78	81	92	91	+14	+10
78	81	81	81	+ 3	0
85	81	84	81	− 1	0
66	31	69	51	+ 3	+20
41	0	63	21	+22	+20
70	51	76	71	+ 6	+20
85	81	85	81	0	0
89	91	91	91	+ 3	0
78	81	76	71	− 2	−10
65	31	81	81	+16	+50
78	81	88	91	+10	+10
88	81	92	91	+ 4	0
79	81	86	91	+ 7	+10
83	81	81	81	− 2	0
76	71	90	91	+14	+20
76	71	76	71	0	0
80	81	81	81	+ 1	0
73	61	74	71	+ 1	+10
68	41	75	71	+ 7	+30
82	81	88	91	+ 6	+10
83	81	82	81	+ 1	0

N = 59.

Findings

Table 1 indicates the actual raw scores and percentile ranks[5] of each participant in Form A and B of the Shaw-Troyer Health Knowledge Test, as well as the raw score increase and percentile increase in B as compared to A.

1. Of the 59 people who took both forms of the test, there was a total gain of 338 in raw score or an average gain in raw score of 5.7 per individual.

2. Seven of the 59 people had lower raw scores on Form B than on Form A. Four received the same grade and 48 received higher grades. The range was from minus 9 to plus 22 above the score on the first test.

3. In terms of percentile, two individuals fell in a lower decile in the second test as indicated by norms for the test, 23 fell in the same decile and 34 were in a higher decile. The range was from −20% to +50%.

[5]The figures on norms are taken from tables in the manual accompanying the Shaw-Troyer test. These norms are listed in deciles and so the second test score would have to fall in a decile either above or below that in which the first test fell in order for a change to be indicated.

TABLE 2

Frequency Distribution of Differences on Raw Scores of Form A and Form B of the Shaw-Troyer Health Knowledge Test

Form A: d	f	Form B: d	f
22	1	6	6
21	0	5	3
20	0	4	5
19	1	3	6
18	0	2	2
17	0	1	5
16	1	0	4
15	1	−1	2
14	4	−2	3
13	0	−3	0
12	2	−4	0
11	2	−5	0
10	3	−6	0
9	1	−7	0
8	3	−8	0
7	3	−9	1

$N = 59.$

$\overline{D} = 5.7.$

$$t = \frac{\overline{D}}{\sqrt{\frac{\Sigma(D-\overline{D})^2}{N(N-1)}}}$$

$t = 2.59.$

TABLE 3

Instructors' Ratings of Individuals and the Mean Peer Ratings of Individuals by the Members of Their Group

Group A		Group B		Group C		Group D	
Col. 1[1]	Col. 2[2]	Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2
12.9	15	8.3	2	8.2	9	1.2	1
15.9	14	4.0	6	12.6	14	8.7	10
8.7	11	8.9	7	10.5	8	8.9	8
12.7	16	6.2	5	2.1	2	8.3	15
7.0	8	4.2	4	5.7	7	9.5	9
4.0	7	10.3	14	6.7	5	11.0	12
9.0	10	5.1	1	7.1	6	8.3	11
6.2	5	8.5	8	12.5	15	2.2	3
15.4	17	8.3	13	5.5	1	8.0	6
1.6	1	5.6	3	8.3	4	9.0	7
9.9	6	13.2	15	5.8	3	2.7	2
3.6	2	9.8	11	9.9	13	5.4	4
13.3	12	10.2	12	8.5	10	8.5	5
6.5	3	9.4	9	8.6	11	6.3	14
5.8	4	6.6	10	7.6	12	10.5	13
10.1	13						
8.6	9						

[1]Column 1 in each instance is the mean peer rating of a student. This is an average of the rating given each student by all the members of his group.

[2]Column 2 in each instance is the instructor rating of a student.

4. The average gain per individual in percentile ranking was 11.1 per cent.
5. The differences between raw scores on Form A and Form B are statistically significant ($t = 2.59$) to the .005 level of confidence.

Table 3 indicates the instructor ratings of individuals and the mean peer ratings of individuals by the members of their groups. The correlation coefficients for the instructor and group evaluative ratings are indicated below:

1. Instructor of Group A and mean peer ratings of Group A	r — +.69
2. Instructor of Group B and mean peer ratings of Group B	r — +.90
3. Instructor of Group C and mean peer ratings of Group C	r — +.81
4. Instructor of Group D and mean peer ratings of Group D	r — +.74
5. Instructors of Groups A, B, C, D and mean peer ratings of Groups A, B, C, D	r — +.82

The correlation of mean peer ratings of individuals in Groups A, B, C, D and their scores on Form A of the Health Knowledge Test was +.38. The correlation of mean peer ratings of individuals in Groups A, B, C, D and their score on Form B of the Health Knowledge Test was +.01.

Summary and Conclusions

On the Health Knowledge Test given at the beginning and at the end of the Workshop, the results tended to show a fairly consistent increase in the number of correct questions on the second test (Form B) as compared with the number of correct questions on the first test (Form A). This increase was clearly evident in the gain in percentile ranking on the second test as compared with the first test, and the differences between scores on Form A and Form B are statistically significant.

The correlations of instructor and peer ratings (+.82) is highly significant.

Apparently, there is very little relationship between a student's knowledge in health education and the rating of his contribution to a workshop situation, as measured by staff and fellow workshop members. There is, on the other hand, unusually high agreement between the instructor and fellow students as to the contribution of an individual to the workshop.

On the basis of this study, the authors feel that more weight should be given to student and faculty opinions of the contribution of a student (particularly in a workshop situation) in determining final grades as compared to the emphasis placed on actual knowledge gained as measured by objective tests.

(Submitted 1-11-54)

Some Physiologic Effects of Isometric and Isotonic Work in Man

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Abstract

An apparatus for measuring isometric work is described. A comparison is made of the blood pressure changes resulting from isometric work and isotonic work. The isometric work causes sharp rises in systolic and diastolic blood pressures while the isotonic work causes significant changes only in the systolic blood pressure.

THE DEVELOPMENT and use of the strain gauge principle has opened a new avenue of approach to the study of work and the physiologic responses associated with various types of work. This study makes use of the new strain gauge dynamometer and the technique described by Tuttle, Janney, and Thompson (1).

Dynamometers of various types have been used to measure work (Strength) since their introduction by Brigham in 1872 (2). Strength in general has been measured either by contraction (3, 4, 5) or breaking strength (6, 7) expressed as pounds or kilograms. Generally, dynamometers have been employed to measure maximum strength. To complete the picture of strength in man the amount of tension developed over a period of time should be studied as well as the maximum strength.

Isometric work is adaptable to measurement over a period of time. Isometric work is a type of work in which the muscle contracts but does not shorten. The maximum hand-gripping strength for a period of one minute was used as the isometric work bout to be studied. The effect of the isometric work on arterial blood pressure was observed and comparisons of the blood pressure changes during the isometric work with changes in blood pressure during a light bout of isotonic work are presented. Isotonic work is a type of work in which the muscle contracts and shortens.

Description of Apparatus

General Description of the Grip Dynamometer. The dynamometer is shown in Figure I. The subject places his hand around the grips A and B with the little finger against the stop C. This insures that the hand will be in the same position on the dynamometer when repeated tests are made. When the subject squeezes, the lower ends of the dynamometer are pulled together, thus causing a small amount of bowing in the region above the fulcrum D. The bowing activates a strain gauge (Statham Model G1) E. This arrangement is used

since the force required to actuate the gauge is much smaller than the grip strength.

The dynamometer is made of tool steel with the dimensions as shown in Figure I. The grips A and B are made of aluminum and are secured by screws. As described, this dynamometer provides for a full scale reading of 170 pounds. Other dimensions may be used to give either larger or smaller full-scale readings, but this is sufficiently large to measure the grip strength of the majority of men. Because of possible variations in the modulus of elasticity, different dynamometers may give somewhat different full-scale readings even though they are made to the same dimensions.

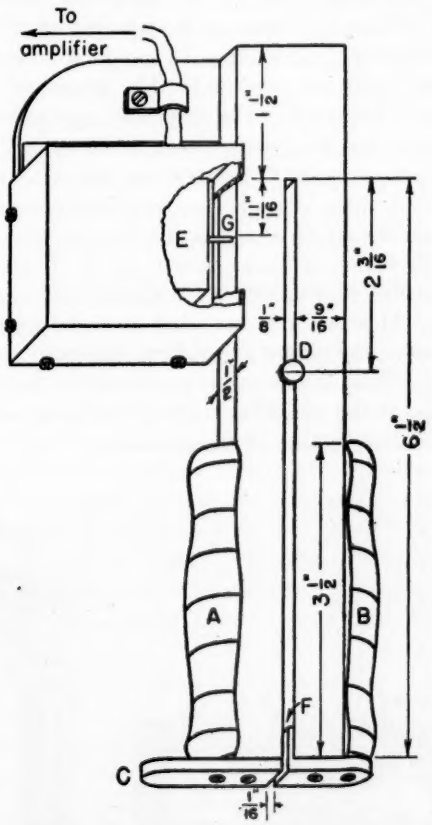

FIGURE I. Grip Dynamometer for Men.

It is necessary to protect the strain gauge against movement beyond its normal limit which in this instance is 0.0014 in. This limitation of the movement is accomplished by inserting between the handles of the dynamometer a block F, Figure I, of such thickness that a mechanic's dial indicator placed

at G reads a displacement of slightly less than the movement limit of the gauge (0.0014 in.), when the handles of the dynamometer are squeezed together. The range of the instrument is then the force required to close the handles of the dynamometer.

Strain Gauge. The strain gauge contains a Wheatstone bridge. The four resistance elements are stretched wires. When the pin, which contacts the side of the dynamometer at G is depressed, two wires, in opposite legs of the bridge, are stretched further and the other two wires are allowed to shorten. The result is a slight increase in resistance in the first two wires and a slight decrease in resistance in the second two wires. If the bridge was balanced to begin with, it now is unbalanced. The movement of the pin is so slight that the output voltage is linearly related to the amount of depression of the pin.

Amplifier and Recorder. Obviously, if one is to record the output of a gauge, an amplifier must be employed. The amplifier, dynamometer and recorder are shown in Figure II. The amplifier for the output voltage of the bridge and the supply for the input voltage are mounted as small units in a single cabinet. They are connected to the strain gauge by a four wire shielded cable. The input is 2.5 volts, 60 cycle a.c., supplied by a filament transformer. The a.c. output from the strain gauge is fed into an electronic a.c. amplifier, with a characteristic which is linear over most of its range. The output of the amplifier is rectified and operates a 5 ma.d.c. Esterline-Angus recording meter (Figure II). This meter is operated at a chart speed of 3 inches (4 divisions) per minute. The output signal from the strain gauge is proportional to the input voltage. Thus it was necessary to adjust the input voltage to the gauge and the gain of the amplifier so that the range of the dynamometer corresponds to the full deflection of the recorder.

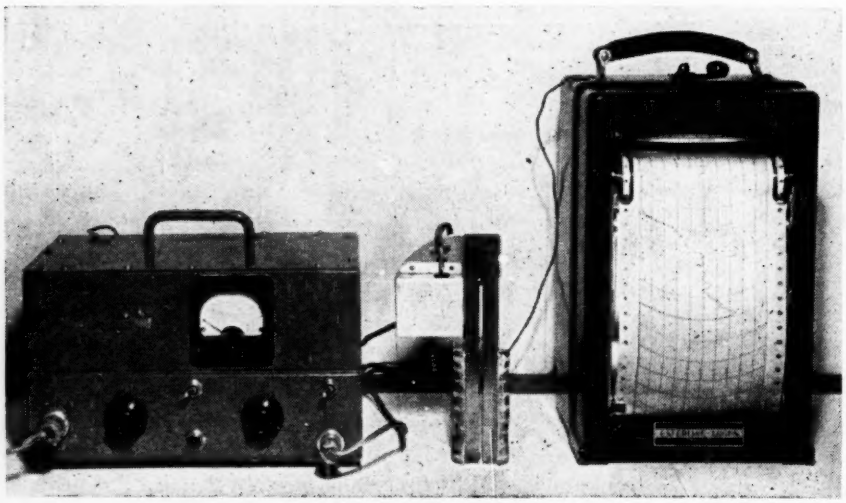

FIGURE II. Amplifier, Dynamometer, and Recorder.

Discussion of Effects

EFFECT OF ISOMETRIC WORK ON ARTERIAL BLOOD PRESSURE

The dynamometer employed for measuring grip-strength endurance provides a method for performing isometric work, since the movement provided by the apparatus is as small as is possible yet making measurement possible. The isometric work done in this experiment consisted of squeezing the grip dynamometer at a maximum effort for one minute. The record of this work includes the maximum strength and the strength endurance both of which can be expressed in pounds.

During the last 15 seconds of the work period both the systolic and diastolic blood pressures were recorded by the conventional clinical method from the resting arm. The blood-pressure recovery is followed by reading the blood pressures 30 seconds and 60 seconds after the work effort.

The data collected from 26 men subjects, all university students, between the ages of 20 and 35 years are shown in Table 1.

Statistical treatment of the data by the t-test indicated in Table 2 shows the results to be highly significant. The data shows that 30 seconds after work diastolic pressure has returned to the resting level and after 60 seconds systolic pressure has practically returned to normal.

A COMPARISON OF THE EFFECT OF ISOMETRIC WORK AND ISOTONIC WORK ON ARTERIAL BLOOD PRESSURE

It is generally accepted that strenuous bouts of exercise of short duration cause a sharp elevation of systolic blood pressure which persists for several minutes. It is also a well-known fact that similar bouts of exercise result in no significant change in diastolic blood pressure. Since the effect of isometric work of a small magnitude causes reactions which are dissimilar in some respects to those resulting from isotonic work, it seemed worthwhile to compare the effect of the two types of exercise.

In order to make the desired comparison, sixteen male subjects were used. The isometric work consisted of squeezing the grip dynamometer for one minute at maximum effort while the isotonic work was a one-minute bout of exercise on a bicycle ergometer where 1250 kgm. of work was done.

The data collected from the subjects are shown in Table 3.

An examination of Table 3 reveals the fact that in the case of isometric work, the systolic blood pressure increased sharply during the work but returned to the resting level within one minute after the end of the work. In contrast, the isotonic work caused a sharp rise in systolic blood pressure for more than one minute. In the case of isometric work the diastolic blood pressure was sharply elevated during the work but was not significantly different than the resting level 30 seconds after the end of the effort. In contrast, isotonic work caused no significant rise in diastolic blood pressure.

It is evident from the data presented in Table 3 that the effects of isometric and isotonic work are different relative to their effects on blood pressure. The

difference is chiefly concerned with the diastolic blood pressure. Table 4 indicates the statistical levels of significance of the arterial blood pressure results of the isometric and isotonic work. Although the amount of isotonic work done is much greater than that accomplished by gripping the dyna-

TABLE 1

Effect of One Minute of Isometric Work on Arterial Blood Pressure[1]

Subject Number	Arterial blood pressure			
	Resting	Last 15 Sec. Work	30 Sec. After Work	60 Sec. After Work
1	128/90	138/96	136/96	134/94
2	136/96	186/136	154/88	142/92
3	136/92	166/118	142/90	132/90
4	132/94	194/136	142/96	136/98
5	132/76	206/134	152/78	144/76
6	132/88	166/188	136/94	138/98
7	132/86	184/118	144/84	138/84
8	128/76	174/128	150/80	138/82
9	128/76	164/122	136/78	138/78
10	126/94	158/118	122/92	
11	126/84	168/128	136/82	132/82
12	126/76	166/132	134/80	132/78
13	122/88	168/130	134/82	124/80
14	122/80	154/114	132/84	126/78
15	120/88	202/138	144/86	134/84
16	108/78	138/104	114/82	108/78
17	116/78	154/106	140/74	118/78
18	122/86	180/110	140/86	130/88
19	112/78	180/120	140/78	128/78
20	120/82	154/118	130/78	120/80
21	118/76	170/124	130/80	118/78
22	118/80	180/110	140/78	134/76
23	128/84	150/104	134/80	132/84
24	108/78	180/126	160/86	140/82
25	106/78	148/118	126/90	120/84
26	114/82	160/120	126/84	124/84
Mean	123/83	169/120	138/84	130/84
S.D.	27/6	17/16	9/6	10/6

[1]Blood pressure expressed in mm. Hg.

TABLE 2

Level of Significance of Isometric Work on Arterial Blood Pressure

Period	t	Level of Significance
Rest and last 15 sec. work	7.27/7.25	.01/.01
Rest and 30 sec. after work	2.69/ .520	1/62
Rest and 60 sec. after work	.92/ .346	37/77

TABLE 3

Comparison of Arterial Blood Pressure Changes Resulting from Isometric and Isotonic Work[1]

Subject Number	Isometric work				Isotonic work				
	Before Work	Last 15 Sec. Work	30 Sec. After Work	60 Sec. After Work	Before Work	Last 15 Sec. Work	30 Sec. After Work	60 Sec. After Work	180 Sec. After Work
1	122/82	170/110	130/80	122/82	136/92	178/92	164/92	150/92	136/92
2	112/82	172/116	140/80	122/82	136/92	178/92	172/92	150/92	136/92
3	120/80	154/104	122/82	120/80	120/74	160/74	150/74	130/74	120/74
4	120/80	160/108	124/80	120/80	120/76	154/76	146/76	130/76	122/76
5	114/80	164/120	124/84	114/80	122/78	168/78	167/78	166/80	134/80
6	116/80	150/120	140/80	118/80	124/80	200/80	190/80	180/76	158/76
7	124/82	146/118	126/100	124/82	124/84	170/84	148/80	144/84	140/84
8	124/86	148/118	126/94	126/84	124/84	184/84	164/84	150/84	124/84
9	106/82	168/112	146/80	108/80	122/84	172/84	162/82	150/84	124/84
10	114/80	166/102	130/80	116/80	120/80	190/80	186/78	180/74	144/80
11	120/80	162/110	124/72	120/80	126/80	178/74	156/72	144/80	132/80
12	118/84	168/126	146/84	120/80	124/80	180/80	170/79	150/79	130/80
13	120/92	164/124	118/84	116/96	122/84	170/84	164/84	154/86	126/84
14	124/88	160/124	120/92	120/89	124/86	176/88	172/86	168/86	128/86
15	122/82	156/110	150/96	124/82	124/86	186/86	180/86	170/86	152/86
16	130/84	160/130	140/94	130/84	128/88	186/90	182/90	172/88	140/88
Mean	120/83	161/116	131/87	120/83	125/83	190/83	167/82	156/83	129/83
S.D.	7.68/3.60	7.81/8.43	10.30/8.37	6.25/4.69	20.17/5.0	11.23/6.25	13.04/6.0	15.75/4.90	10.86/5.74

[1]Blood pressure in mm. Hg.

TABLE 4

Levels of Significance of the Comparison of Arterial Blood Pressure Changes Resulting from Isometeric and Isotonic Work

Work	Rest and Last 15 Sec. Work	Rest and 30 Sec. After Work	Rest and 60 Sec. After Work	Rest and 60 Sec. After Work
Isometric work				
t	14.4/13.5	1.05/1.63		
Level of significance	0.01%/0.01%	32%/12%	—	—
Isotonic work				
t	10.8/0	6.8/0	4.7/0	0.68/0
Level of significance	0.01/—	0.01%/—	0.01%/—	49/—

mometer, the isometric work causes a significant rise in diastolic pressure while the isotonic work results in no significant change.[1]

These facts lead to the conclusion that different mechanisms are operating in the two types of work as far as the diastolic blood pressure is concerned. It is suggested that the chief cause of the blood pressure changes in isotonic work is chemical in nature while those involved in isometric work are reflexive.

Conclusions

On the basis of the data presented the following conclusions are drawn:

1. Isometric work causes a sharp rise in both systolic and diastolic blood pressure. The diastolic blood pressure has returned to resting level within 30 seconds.

2. In contrast to isometric work, a moderate bout of isotonic work of short duration causes no significant change in diastolic blood pressure.

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[1]The experiments conducted have shown that on the basis of the oxygen required to do the two types of work, four times as much oxygen was required to do the isotonic work as was used in doing the isometric work.

(Submitted 1-11-54)

Notes & Comments

NOTES

A Note on Physiological Limits and the History of the Mile Run

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IT IS NEARLY a century since Webster of England ran the mile in 4:44.3 (1865). If one had graphically portrayed the successive records for this popular event in say 1885, the consistency of the steady exponential decline (Figure I) would have justified the prediction that in another 10 years or so the ultimate performance would be achieved—about 4:15.0 or perhaps 4:14.5. This prediction would have been confirmed by the Conneff mile in 1895 (not to be exceeded until the amazing John Paul Jones ran the distance in 4:14.4 in 1913). Two years later Taber turned in a "super-human" performance; he improved the record by nearly 2 seconds.

With the advent of the Flying Finn in 1923 (he bettered the Jones record by a full 4 seconds) the writer recalls that two explanations were current: a) Nurmi had a most unusual physiology, probably a racial characteristic, and b) the Finns had learned the secret of how to train, and also had a special distance technique. Nevertheless, the new improvement in speed was regular and progressive (broken line, Figure I), and one could have determined mathematically that the ultimate was again being approached.

The performance of the great French runner, Ladoumegue, should therefore have occasioned no surprise to a scientifically minded person when he made the distance in 4:09.2 in 1931. The speed of Lovelock two years later could *not* have been predicted—nearly two more seconds off the record again, and in the background Cunningham was

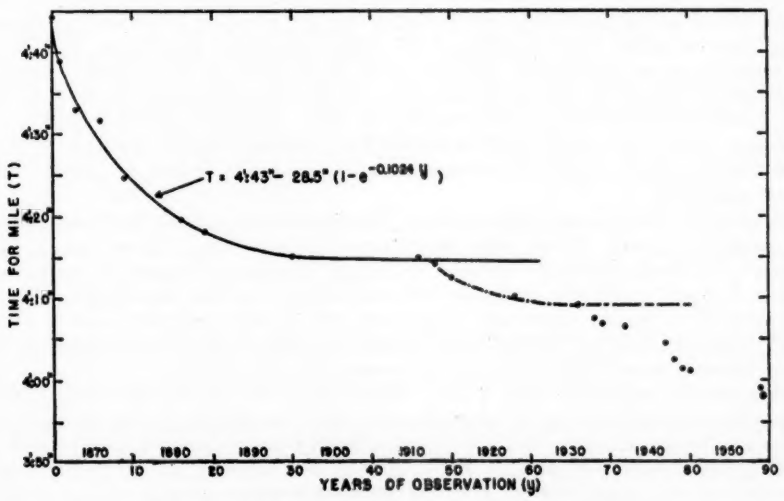

FIGURE I. Progressive Decline in the Mile Record

pressing hard, to hold the record at 4:06.8 in another year. Three more years, and Sidney Wooderson brought the record back to England; five more years and two seconds faster time took it to Sweden where Haegg and Andersson worked it down to 4:01.4 by 1945. The fabulous four-minutes flat was in sight—it might represent the new physiological limit, although some denied that such a performance would ever be possible.

Recent events can best be appreciated by examining the lower right corner of the graph in relation to earlier data. The lesson is clear. Neither consistency of performance nor trend of the empirical improvement curve gives us any dependable information about the physiological limits of human performance.

Personality Traits of Some Champion Athletes as Measured by Two Projective Tests: Rorschach and H-T-P

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A FEW WORDS OF orientation relative to projective personality test theory. "Projection" refers to an unconscious process whereby one's mental content is projected outwardly to some external object—as, for example, when one "sees" faces, animals, and the like in cloud formations. In projective personality testing, subjects are confronted with some "unstructured" stimulus, in the case of the Rorschach test, ten ink blots; and as in the case of looking at clouds, they are asked to tell what they see in the ink blots. In this way, information about psychic content can be elicited which subjects would not or *could not* otherwise reveal. There are no right or wrong answers, and since subjects are not aware that in responding to the stimuli they are revealing and describing themselves, their responses are not restrained by cultural taboos or inhibitions. Projective test evaluation is an exceedingly complex matter of interpreting the symbolic meaning of the responses, and has not as yet attained a highly scientific status. (1, 3, 6, 7, 8)

In a previous projective personality study (5), three champion athletes stood out as possessing certain exceptional personality traits in common. On the strength of this observation, the present exploratory investigation was conducted dealing exclusively with athletic champions.

The subjects of the present research were 12 national champions or All-Americans in their respective sports. (Three were runners-up or second team All-Americans.) The subjects: 4 football players, 2 Lacrosse players, 2 wrestlers, 2 boxers, 1 track man (middle distance) and 1 rifle marksman who, incidentally, had had considerable athletic experience. With two exceptions, the subjects were not in their competitive seasons when tested. The exceptions had finished their season but anticipated a final tournament in several weeks. Two of the subjects had not competed in recent years.

Two projective personality tests, a group Rorschach (4, 6) and the chromatic H-T-P (House-Tree-Person Test) (2, 3) were administered to the subjects by the first author, and were evaluated according to standard procedures by the second and third authors—clinically experienced psychologists and projective test experts. In particular, these individuals were instructed to compare this group with the respective test norms and to specify any identifying characteristics that the group might have.

The evaluation was done blind; i.e., the test evaluators were not aware of the specific nature of the study, the types of athletes, or the subjects' personal identifications. The evaluators had no contact with one another.

Analysis of the test findings revealed that there were certain salient points upon which the two tests were in striking agreement. In the first place, the champions were readily distinguishable as an exceptionable group in comparison with both test norms and the personal experience of the evaluators. Both evaluators named the following as being the most outstanding personality characteristics of the group:

1. Extreme aggression
2. Uncontrolled affect (emotions lacking strict controls)
3. High and generalized anxiety
4. High level of intellectual aspiration
5. Exceptional feelings of self-assurance.

The H-T-P test further indicated that these subjects were exceptionally able to concentrate personality resources upon the desired objectives; this test also pointed up an unusual concern in these subjects for physical power and physical perfection.[1]

Although generalizing from this small sample of champions would be unjustified, certain personality patterns were surprisingly consistent throughout this particular group. The subjects' extreme agressiveness, anxiety, and sufficient freedom from emotional controls to aggress freely under certain conditions—coupled with a high level of aspiration—would suggest a strong need for competitive achievement. The evidence suggests that in these subjects, being a champion was a matter of psychological necessity.[2]

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[1]The test evaluators were also instructed to compare sub-groups composed of combative and non-combative sports athletes. According to the Rorschach, the non-combative athletes were more like one another than they were like the combative athletes. In consideration of the small groups, these findings were nothing more than suggestive. This comparison was not made with the H-T-P test.

[2]An intensive study of the personalities of contemporary eminent scientists was conducted by A. Roe (7). Her study revealed that intelligence was but a basic factor in extraordinary scientific achievement—tremendous inner drive being another (as it would also appear to be in the champion athlete). Roe had no way of knowing what influence spending years at scientific research had upon the personality dynamics of the scientists. Analogously, the present investigators had no way of knowing in what ways the champion athletes' personalities had been influenced by years of athletic competition.

COMMENTS

Comments on Phebe M. Scott's article on "Attitudes Toward Athletic Competition in Elementary Schools" in the October 1953 *Research Quarterly*

THIS RESEARCH project came to the conclusion that administrators, teachers, and parents favored by a substantial margin competition among elementary schools in athletics. The experimental design and statistical results have been studied to see whether or not the conclusion was justified. Several aspects of the research were found which seemed to raise questions regarding the general conclusion. These are as follows:

First, as to the selection of schools to be included. In any sampling study of opinions or attitudes where the potential participants are asked whether or not they wish to cooperate, and the nature of the study is revealed, the group which then becomes the basis for the study is already biased. This is because those who participate tend to be those who feel strongly about the subject. For this reason, the results, regardless of how they come out, could not be interpreted too well.

Second, the research states that the correlation coefficient between the scores the administrators made and the scores of those they asked to participate in the study was .606. This coefficient is dismissed by the researcher as not being high enough to mean anything. Actually, in this case, any correlation which differs substantially from zero would immediately mean that the superintendent either picked his teachers, parents, and coworkers because they were sympathetic to his viewpoint, or that there had been a spread of attitudes between the administrators and their co-workers. This means that since the cities had a majority of superintendents who favored competition, that they also had captive groups selected from the teachers, parents, and other administrative staff sympathetic to the viewpoint.

From the biases shown in the selection of subjects in this study, both as to the original school systems and internally within each school system, it is felt that the general conclusion regarding the attitudes of parents, teachers, and administrators made in this study are not based on the data presented.—*David Segel, U. S. Office of Education.*

Some criticisms of the article by Margaret Bell, C. Etta Walters, and Staff on "Attitudes of Women at the University of Michigan Toward Physical Education" in the December 1953 *Research Quarterly*

TO THE UNWARY reader, statements made by the authors of this particular survey may be accepted wholeheartedly, when in reality, upon closer examination, the reader may note various discrepancies occurring periodically.

A total of 173 Seniors and 684 Freshmen were used as a sampling and from this point on, comparisons are drawn between the two groups. It is possible, perhaps, that if a comparable number of Seniors had been used, or, if the Freshmen sampling had approximated the Senior sampling, the results of this study might have been different than that actually pictured by the authors. Hence, the sampling procedure in this report might be open to question.

The authors state: "A total of 173 Seniors and 684 Freshmen *answered*[1] the questionnaire" (p. 380). However, in reviewing Table I, titled, "Average Amount of Time Spent per Week in Physical Activity" (p. 380), we find a total of 665 Freshmen and 151 Seniors listed as answering the questionnaire. The authors continue: "An analysis of Table 1 shows that 288 out of 665 Freshmen (42%) ....." This 42% as listed should be 43%.

[1]Italics that of the writer.

Examining Table 1 further, one may note the Senior column totaling 151, which, correctly computed, should be 161. Accordingly, the percentage column following Seniors should read:

Seniors N	%
10	6
10	6
27	17
31	19
53	33
30	19
Total 161	100

The corrections in five of the percentages obviously could change some of the inferences made by the writers, e. g., "An analysis of Table 1 shows that 288 out of 665 Freshmen (42%) spend from three to five hours per week, outside of physical education class, on physical activity, while only 47 out of 151 (18%) of the Seniors spend that much time" (p. 380). The figure, 151, should be 161 and the percentages, 42 and 18, corrected should read, 43% and 29%, respectively.

In looking at Table 2 (*p. 381*), four errors are noticeable. In "Extra-curricular," % of Total, N (173) column, one reads 41 which should be 42; in "Lack of initiative," % of Total, N (173) column, the figure 19 should be 20; in "No opponent," % of Total, N (173) column, should read 10 in lieu of 11, and in "Facilities not available," % of Total, N (684) column, the number 11 should be 12.

These corrections automatically change the interpretation as cited by the authors (*p. 380*), e. g., in extra-curricular activities 29% of the Freshmen and 42% (not 41%) of the Seniors, and in lack of initiative 7% of the Freshmen listed it as compared to 20% (not 19%) of the Seniors.

The standard error of the mean (Table 3), indicating .81 for Freshmen who had taken physical education in high school should be .80 and the standard error of the mean for Freshmen who had no physical education in high school should be 2.32 rather than 2.23.

"To check reliability, the questionnaire was given twice to 150 Freshmen" (*p. 380*). The term reliability, when used, should be rigidly defined and definitions carefully adhered to. That there are important limitations to this procedure used by the authors is well known, namely:

1. If time between testing is too short, the individual will remember many of the answers they gave on the first trial and mark the same answers on the second trial. This factor tends to make the correlation between the two sets of scores higher than the true reliability coefficient.
2. The danger between having too long an interval between the tests is that some of the individuals will have received training in the characteristics tested.
3. By utilizing the test-retest method, it is difficult to maintain comparable testing conditions for the two testings. In addition, it has been pointed out that the test-retest coefficient is affected not only by the unreliability of the test but also by any lack of stability of the function being tested.
4. Finally, because of the fact that the above-mentioned obstacles are so frequent in the test-retest method, it is rarely used.

—B. Everard Blanchard, Plymouth Teachers College, Plymouth, N. H.

Comments on the article by Donald K. Mathews on "Comparison of Testors and Subjects in Administering Physical Fitness Index Tests" in the December 1953 *Research Quarterly*

IN THIS REPORT, Mathews (5) summarized an experiment concerned with the comparison of PFI scores obtained by experienced and inexperienced testors upon non-oriented and oriented subjects. As described by this investigator, the experimental design involved the following:

First test: In the initial testing situation, the subjects had had no prior experience in taking PFI tests. The testors were seven inexperienced senior students in the course, who administered the tests for the first time.

Second test: The same subjects were again given the PFI battery, thus benefiting from the previous experience. This time, however, the testors consisted of the Tests and Measurements Laboratory staff (all of whom had administered the PFI on numerous occasions).

In analyzing the data thus obtained, the investigator computed t-tests for the differences between means for the experienced and the inexperienced testors for all PFI test items. Since all t-tests were found to be significant, it was concluded that "the results of this experiment clearly illustrate the fact that the PFI test can be no better than the capabilities of the examiner." It was also concluded that "the learning factor would certainly help to account for more valid scores," and that "one or more practice sessions should precede the actual testing program."

The results of this experiment, however, are somewhat ambiguous. And there would seem to be little logical justification for the investigator's conclusions as to the effect that the differences between means has been due to the factors of experienced testors *and* practice or learning on the part of his subjects. The design or structure of the experiment is such that no clear-cut interpretation is possible. In accounting for the fact that measures obtained during the second test period were significantly higher than those obtained during the first test period, one is confronted with several possibilities: (1) the differences may be due to practice or learning on the part of the subjects; (2) the differences may be due to the capabilities of the testors; or (3) the differences may be due to both practice effects *and* the capabilities of the testors.

Unfortunately, the structure of Mathews' experiment provides no information as to which of the several logical possibilities produced the experimental results. It is, for example, entirely possible that the differences between means may have been due solely to practice or learning on the part of the subjects. Under this condition, simply reversing the order of testors might result in the inexperienced testors obtaining significantly higher mean scores on the PFI test items.

It is the suggestion of this note that the Mathews' experimental design is not a very useful one in physical education research. Although the design does permit one to estimate the presence or absence of significant effects, it does not permit a clear-cut interpretation as to the probable causes of the effects. Experimental designs which will permit clear-cut interpretations can be found in such sources as Cochran and Cox (1), Edwards (2), Kempthorne (3), and Lindquist (4).

In closing this note, the writer would like to congratulate Mathews on bringing to light one or more variables which undoubtedly influence PFI test scores. This in itself is a significant achievement. It is hoped that Mathews plans further research along these lines, research which will provide precise information as to the relationships between PFI test scores and practice or learning on the part of subjects and the capabilities of the testors.

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—Arthur T. Slater-Hammel, Indiana Univversity

Research Abstracts

Anatomy and Physiology

52. Blockey, N. J. An observation concerning the flexor muscles during recovery of function after dislocation of the elbow. *J. Bone and Joint Surg.*, **36-A**, 4 (July 1954).

Factors governing the recovery of joint movement are obscure and difficult to define. Simple mechanistic explanations that are sometimes the bases for physical therapy do not suffice.

Sir Robert Jones refers to pain as a natural reflex that is nature's method of controlling voluntary movement. Nicoll believes that the key to success is muscle power, and Doran believes that muscle strength is the basis for overcoming non-osseous obstructions.

Twenty cases of dislocation of the elbow joint were studied. The authors concluded that the pain reflex and muscle strength were not the determining factors in attaining movement, but that a joint protection reflex seems to be initiated by receptors other than pain receptors. He believed that increase in motion occurred by resolution of the products of joint damage, which is a primary phenomenon and not the result of the power of the muscles overcoming the tenacity of the adhesions.—*Frank D. Sills.*

53. Carlsten, A., *et al.* "Relationship between low values of alveolar carbon monoxide concentration and carboxyhemoglobin percentage in human blood", *Acta Physiologica Scandinavica*, **31**:62-74 (June 1954).

Alveolar CO concentration and COHb percentage in blood were determined in 55 subjects before and after exposure to low concentrations of CO. Percentage of COHb in blood increased, approximately, in direct relationship with increasing values of alveolar pCO within the investigated range (below 6% COHb). The mean value of M in Haldane's equation $\frac{(COHb}{(O_2HB} = M. \frac{pCO)}{pO_2)}$ for the whole range of alveolar CO concentrations was 245. No real variation of M between different subjects could be established. When a small amount of CO was administered to a subject, the increase of COHb percentage was related to the increase of alveolar CO concentration by the value of M of 228 ± 6, S.D. 45 ± 5.—*Paul Hunsicker.*

54. Fisk, Guy H. and Garret Colwell. Shoulder movement in health and disease. *Modern Medicine*, Sept. 1954.

Roentgenographic studies show that movement in the shoulder joint is similar for healthy persons, and that disease or injury of the shoulder will affect the joint between the humerus and scapula. The physique and musculature have no effect on the range or component details of movement as indicated by an analysis of office workers, coal heavers, and others. Women were found to have a greater range of scapular movement on the thorax than men.

Correction:

In the October *Research Quarterly*, page 371, line 1 of Research Abstract 39 should have read: "After 23 years of somatotype research and three basic texts,[1] Dr. Sheldon and his." Please make this correction in your file copy.

Roentgenograms of the shoulders of active and sedentary healthful individuals revealed that in all phases of shoulder action, movements occur at the scapulohumeral, scapulothoracic, acromioclavicular, and sternoclavicular joints. The roentgenograms were taken with the humerus in six different positions.

In periarthritis, rheumatoid arthritis, and fracture of the surgical neck of the humerus, limitation of movement is at the scapulohumeral joint.

The presence or absence of the supraspinatus is of little or no importance to the range of the shoulder movement.—*Frank D. Sills.*

55. ZENOVIEFF, A. "The after-care of fractures," *Archives of Phys. Med. and Rehabilitation.* **25**:303-306 (May 1954).

The three cardinal principles of treatment of a fracture are: (1) to reduce displacement when present; (2) to immobilize the fractured bone adequately, to obtain bony union as quickly as possible, and (3) to insure little or none of the functional disability which may result from the fracture and its immobilization. The paper is primarily concerned with the third principle.

In maintaining function, three points must be considered: (1) the maintenance of movement of all the free joints of the injured part; (2) the maintenance of the tone and strength of the muscles of the injured part, and (3) the maintenance of the highest possible level of function of the injured and immobilized part.

Active movement is the keynote of the after-care of fractures. Heat of various kinds is useful in relieving pain and as a preliminary to joint and muscle exercise. Hydrotherapy is valuable as combining heat and active movement, particularly in the early stages. Massage, all too often prescribed, is of very limited use. It can help to loosen the adhesion of fairly recent scars; it can help to establish that most rapid of well marked edema, and it can ease discomfort. Electrical stimulation may be used to reduce atrophy in paralyzed muscles and to reorient the patient's sense of movement of a muscle.—*Peter Karpovich.*

Educational Psychology

56. AMATORA, SISTER MARY. Similarity in teacher and pupil personality. *Journal of Psychology*, **37**:45-49 (Jan. 1954).

The relationships between teacher and pupil personality were analyzed by the Pearson method of correlation.

One hundred teachers of grades four through eight and the pupils in their classes were rated by means of personality scales on 22 personality variables. Ratings of teachers and pupils were based on the composite judgment of three or four other teachers, and pupils were also rated by eight of their classmates.

Correlations on each of the 22 variables were obtained between the teachers and the mean ratings of their classes. In every instance, a positive relationship was revealed. When teachers did all the rating, 19 of the correlations were significant at better than the 5% level of confidence. Correlations ranged from .11 to .46. Variables showing degrees of relation of .40 or higher are generosity, nervous-calmness, sociability, and energy and pep. The three variables which did not attain the 5% significance level were sense of humor, good sportsmanship, and religiousness.—*Marjorie Phillips.*

57. BAYLEY, NANCY. Some increasing parent-child similarities during the growth of children. *J. of Educ. Psych.*, **45**:1:1-21. (Jan. 1954).

Most of the physical comparisons show increasing parent-child similarities as the children grow older. Within-sex relationships are stronger than those between parent and child of the opposite sex. Mother-daughter relations are closer than father-son relationships. The trends in mental relations differ in several ways from those of physical relations. The children themselves are more stable in the physical measurements. But the trends of increasing similarity to their parents seem more consistent in the mental

scores. Although there are no sex differences in the parent-child r's for the mental factors, there appear to be some marked sex differences in the physical factors. The author suggests the existence of a hereditary core of parent-child similarities in both mental and physical characters, even though such similarities may not be evidenced during the first year or so of the child's life.—*D. B. Van Dalen.*

58. KEPHART, NEWELL C., and WILLIAM FLOYD, Classroom environment and pupil welfare. *J. of Educ. Psych.*, **45**:1:52-59 (Jan. 1954).

Three areas of development were studied in connection with fourth- and fifth-grade school children in an experimental co-ordinated classroom, as recommended by Harmon, and a similar group who spent the school year in a traditional type classroom evironment. It was found that the experimental group was superior to the class in group achievement as measured by the accomplishment quotient, in the posture of the head in relation to the body (smaller percentage of head-tilts), and in extraneous behavior patterns (lesser frequency of extraneous movements or nervous habits).—*D. B. Van Dalen.*

59. OSTLUND, LEONARD A. Group integration in a case discussion course. *J. of Educ. Psych.*, **44**:8:463-474 (Dec. 1953).

Sociometric analysis of 25 male college students provided qualitative indications, and the sociometric indices were found to be statistically significant. Correlation coefficients affirm that the relationship between student-student variables and teacher-student variables cannot be attributed to chance.—*D. B. Van Dalen.*

Health Education

60. NATIONAL DAIRY COUNCIL. The role of vitamins in nutrition-V. *Dairy Council Digests*, July 1954.

What is currently known of the biochemical roles of thiamine, riboflavin, niacin vitamin B_6 and pantothenic acid was reviewed in the two previous issues of *Dairy Council Digests*. Classified as B-complex vitamins, along with those just named, are biotin, folic acid (folacin), and vitamin B_{12}. Unlike the others, their roles seem to be more restricted to the synthesis of vital body substances than to the utilization of food energy from the major constituents of the diet—fat, carbohydrate, and protein.

Biotin is required by man but a specific dietary requirement under normal circumstances has not yet been established. Biotin appears to be directly or indirectly involved in biosynthesis through the fixation of carbon dioxide.

Folic acid and vitamin B_{12} are effective in the treatment of certain types of human anemias. A specific requirement for folic acid and vitamin B_{12} for man under normal circumstances has not been established.

Folic acid, vitamin B_{12}, choline, and methionine are all involved in the metabolism of single carbon fragments and therefore are essential for normal fat metabolism and the biosynthesis of nucleic acids.—*Paul Hunsicker.*

61. NATIONAL DAIRY COUNCIL. The role of vitamins in nutrition—VI. *Dairy Council Digests*, Sept. 1954.

This is the sixth and final issue of the series of *Dairy Council Digests* reviewing the role of vitamins in nutrition. Human subjects require: (1) 10 to 20 mg. of ascorbic acid daily for prevention of classic symptoms of scurvy; (2) about 25 mg. of ascorbic acid daily for maintenance of healthy gum tissue; and (3) higher levels of daily intake to maintain concentrations of this vitamin in body tissues, comparable to concentrations observed in animal species which synthesize ascorbic acid and, therefore, do not depend upon a dietary source.

Citrus fruits, berries, melons, tomatoes, green peppers, raw cabbage, and salad greens are rich sources of ascorbic acid. In foods, ascorbic acid is the most easily destroyed of all known essential nutrients.

Current evidence indicates that ascorbic acid: (1) possibly functions in the oxidation of tyrosine; (2) may be functionally related to folic acid and vitamin B_{12}, possibly in the conversion of folic acid to folinic acid; (3) is essential for the production of collagen, the basic substance in normal connective tissue of the body; and (4) is involved in oxidation-reduction steps in body synthesis of cholesterol and the steroid hormones.—*Paul Hunsicker.*

Tests and Measurements

62. Adams, Jack A. The prediction of performance at advanced stages of training on a complex psychomotor tosk. *USAF Hum. Resour. Res. Cent., Research Bull.*, 1953, No. 53-49, iv, 44 p.

Basic airmen were given extensive training on a criterion task, the Complex Coordination Test CM701E. 55 others tests were given to determine how well they would predict performance at advanced stages of training on the criterion task. "It was found that printed tests, simple psychomotor tests, and measures from the initial stage of training on the complex psychomotor tests generally did a poorer job of predicting final performance than initial performance on the criterion task. This was consistent with other research findings. However, measures from final stages of training on the complex psychomotor tests did a better job of predicting final than initial criterion task performance."—*Psychological Abstracts.*

63. Bechtol, Charles O. The use of a hand dynamometer with adjustable handle spacings. *Journal Bone and Joint Surg.*, July 1954.

"Grip" is a function that should be evaluated in any hand disability. The use of adjustable handle spacings gives a more accurate evaluation. A cable tensiometer and a hydraulic dynamometer were used for the tests.

The use of the hand in grasping large objects includes, e.g., (1) as a hook in carrying a suitcase and (2) as a grasp in the case of picking up a water glass. Three types of prehension for smaller objects includes (1) finger-tip pinch, (2) lateral pinch (as used in pulling magazine from rack), and (3) finger-nail pinch.

The following factors influence the grip: heredity, size of object, exercise, handedness, variation during the day, variation day to day, age, and pain.—*Frank D. Sills.*

64. Brozek, Josef; Ernst Simonson, and Henry O. Taylor. Changes in flicker fusion frequency under stress. *USAF Sch. Aviat. Med. Proj. Report*, 1953, Proj. No. 21-32-004, Report No. 3, ii, 5 p.

Within a framework of studies on changes in "fitness," the flicker fusion frequency (FFF) was determined during a control period and under the following conditions: (1) moderate visual strain; (2) strenuous visual strain; (3) nutritional stresses; (4) miscellaneous severe stresses—hard physical work, work in hot environment, and lack of sleep. The mechanism involved in the depression of fusion level in situations where such a change has been demonstrated (starvation, strenuous visual work) is not clear and most likely it varies. From the results presented in this report it seems clear that the decrease of the fusion level cannot serve as an index of the degree of involvement of the central nervous system in biologic stresses of the type applied in this study or that this involvement is minimal.—*Psychological Abstracts.*

65. Jokl, Ernst. *Alter und Leistung.* (Age and performance.) Springer: Berlin—Gottingen—Heidelberg, 1954. 75 p.

This book is based on a statistical analysis of the results of a competition, arranged specially for old gymnasts in Germany. Approximately 1600 men, 40 to 84 years old, and 100 women, 32 to 54 years, participated. The competition consisted of prescribed apparatus gymnastics in which the tasks were easier for the older, and of 75 or 100 m. dash, broad jump, and shot put or ball throw. On the whole, the performances showed

very little, if any, deterioration with age. The constancy was particularly marked in the quality of performance in apparatus gymnastics, as assessed by experienced judges. The performances of women between 32 and 45 years in 75 m. run, shot put, and broad jump did not change at all. The running speed of the trained 60-year-old men was still higher than that of untrained men of 40.

In 1952, the mean results in shot put, 75 m. run and broad jump at the age of 46-50 correspond to those men 6-10 years younger, achieved in a similar competition in 1928. This prolongation of the high performance level is brought into relation with the development towards earlier onset of maturation and longer expectation of life, characteristic of the present time. The social, nutritional, and medical background of this phenomenon is discussed, and several examples are given of superior performances by exceptionally young or old people.

The results show that the deterioration of performance generally associated with aging may be prevented by regular training. They also suggest, though they do not prove, that regular training may delay the development of degenerative diseases.—*Martti J. Karvonen.*

66. Slater-Hammel, A. T. Reaction time and speed of movement. *Percept. Mot. Skills Res. Exch.*, 1952, 4, 110-113.

Measurements of reaction time to light and speed of arm movement over an arc of 120° were obtained from 25 male physical education students. Mean reaction time was .224 seconds. Correlations of reaction time with several measures of movement ranged between —.07 and .17, not significantly different from zero. The results of this study are interpreted as simply indicating that measurement of reaction time cannot readily be used to predict speed of movement.—*Psychological Abstracts.*

67. Thompson, Merrell E., Jean P. Thompson, and E. Ralph Dusek. Tests of motor ability or gross muscular co-ordination. *USAF Hum. Resour. Res. Cent., Research Bull.*, 1953, No. 53-25, iii, 35 p.

The authors review physical education tests from the point of view of their use in assessing the gross motor ability of manpower pools and predicting success in military tasks. Some description is presented of tests currently being used with males of military age which measure, primarily, some aspect of gross muscular co-ordination, under the categories of motor educability, motor capacity, motor fitness, motor ability, and strength. The reviewers state that: "Flexible instructions, subjective scoring, limited concepts of validity, and other factors involving a disregard or misinterpretation of principles of test construction have greatly reduced the usefulness of research in this field." 255-item bibliography.—*Psychological Abstracts.*

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D. C. (2)
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